Ontario

Ministry of
Transportation

Research and
Development
Branch

distresses, maintenance alternatives, and performance standards

Technical Report Documentation Page

Pavement Maintenance Guidelines

Authors:	G.J. Chong	Research and Development Branch
	F.W. Jewer	Maintenance Branch
	K. Macey	Construction Office, Central Region

Number:	SP-001	ISBN 0-7729-5834-3 ISSN 0226-9414
Date of Publication:	August 1989	
Ministry Contact:	Pavements and Roadway Office, Research and Development Branch (416) 235-4742	

Abstract:

Preservation of a mature highway system is very important today due to constant budget constraints. It also makes good economical sense to protect billions of capital dollars invested in the highway system. This makes the role of pavement maintenance even more important now.

To make the maintenance task easier and more cost-effective, the Ministry developed a systematic strategy for pavement maintenance. This document is part of that system. It is designed to suit the needs of maintenance field staff — the patrolman, patrol supervisors, and district maintenance staff who have to make decisions every day.

This document provides a simple set of guidelines on how to recognize pavement distresses, their possible causes, how to evaluate the extent and severity of the distresses, the appropriate maintenance treatments for the distresses, and how cost-effective the treatments are when used to correct the distresses.

Comments:	This document is a revision of the manual originally published in September, 1980. The revisions incorporate new performance standards.
Key Words:	pavement maintenance, guidelines, distress extent of occurence, distress severity, maintenance treatment, effectiveness of maintenance treatment, cost-effectiveness comparison
Distribution:	District Maintenance and Patrol Offices, Regional Geotechnical Offices, Highway Design Office, Municipal Road Office

Copyright Status:	Crown copyright © 1989 Ministry of Transportation

Ontario

Ministry of Transportation

Research and Development Branch

SP-001

pavement maintenance guidelines

distresses, maintenance alternatives, and performance standards

G.J. Chong
Research Engineer
Pavements and Roadway Office
Research and Development Branch

F.W. Jewer
Senior Methods Analyst
Maintenance Branch

K. Macey
Senior Construction Technician
Construction Office, Central Region

Published by
The Research and Development Branch
Ministry of Transportation of Ontario
Hon. William Wrye, Minister
D.G. Hobbs, Deputy Minister

Published without prejudice as to the application of the findings.
Crown copyright reserved; however, this document may be reproduced for non-commercial purposes with attribution to the Ministry.

For additional copies, contact:
The Editor, Technical Publications
Room 320, Central Building
1201 Wilson Avenue
Downsview, Ontario
Canada M3M 1J8

Telephone: (416) 235-3480
Fax: (416) 235-4872
CNCP Dialcom Electronic Mail: 23:MIN006

August 1989

Table of Contents

1/ Introduction 1

2/ How to Use the Guidelines 2

3/ Summary of Procedures for Condition Survey and Treatment Selection 5

4/ Distress and Maintenance Treatments Flexible Pavement 9

4.1/ Cracking 11

- Longitudinal Cracking 12
- Transverse Cracking 16
- Alligator Cracking 20
- Map Cracking 24
- Progressive Edge Cracking/Edge Breaking 26

4.2/ Surface Distortions 31

- Surface Distortions 33
- Severe Frost-related Bump 34
- Excessive Crown 35
- Sagging, Dishing, Depression, Settlement 36

4.3/ Surface Defects 39

- Flushing 40
- Potholes 42
- Ravelling/Segregation 44
- Rippling/Shoving 46
- Slippery Surface 48
- Wheel Track Rutting 50

5/ Distress and Maintenance Treatments Rigid Pavement 53

5.1/ Cracking 55

- Cracking 56

5.2/ Joint Deficiencies 59

- Joint Failure 60
- Joint Sealant Loss 62
- Joint Spalling 64

5.3/ Surface Defects 67

- Bump 68
- Potholes 70
- Sagging/Settlement 72
- Scaling/Ravelling 74
- Slippery Surface 76
- Stepping (Faulting) 77

6/ Distresses — Shoulder and Surface Drainage 81

6.1/ Surface Defects 82

- Encroaching Growth 83
- Erosion/Washout 84
- Excessive Shoulder Slope Drop-off 85
- Pavement Edge Drop-off/Excessive Height 86
- Pavement/Shoulder Surface Drainage 87
- Potholes/Cracking (Stabilized or Paved Shoulders) 89

7/ Performance Standards for Maintenance Treatments 91

- Introduction 91
- List of Performance Standards 93

Appendix A

Pavement Maintenance Guidelines: Audio Visual Script — A Working Example 145

Figures

1/ Local Occurrence of Potholes 3

2/ General Occurrence of Potholes 3

3/ Sample of Maintenance Needs Report 6

4/ Procedures for Maintenance Staff 7

1/ Introduction

Ontario has one of the best highway systems anywhere. Years of effort and billions of dollars have been invested. In the past, the emphasis has been on new construction and upgrading standards, but recently tight budgets and rising prices have brought a change. Now, the emphasis is on preserving what we have by maintaining and prolonging the life of our highway pavements. This makes the role of pavement maintenance more important than ever before.

To make the maintenance task easier and more effective, a Task Force of experienced Ministry people has developed a systematic strategy for pavement maintenance. This book is part of that system. It is designed to suit the needs of field staff — the patrolmen, patrol supervisors, and District maintenance staff who have to make decisions every day. The book will help you make the best decision, the one that is most cost-effective. By providing a complete set of guidelines, the book will also help you to make that decision consistently.

For the most part, the guidelines deal with short-term measures — problems that have to be fixed immediately. But they can also be used to identify situations affecting the prolonged life of the pavement. These, of course, should be referred to the Regional geotechnical staff. Such problems are not directly addressed in this Guidelines book. They are only identified.

The guidelines presented in this book contain the following elements:

1. Photographs of the different types of pavement distress (including shoulder and drainage problems). The various distresses are shown in different stages of development.

2. A method for classifying each type of distress according to its severity and extent of occurrence.

3. Lists of suitable treatments or maintenance alternatives for each condition. The lists also give the expected service life of each treatment.

4. Performance Standards that describe each treatment and detail the men, equipment and materials needed. They also show how much can be accomplished by the specified team and, in some cases, the maintenance procedure is illustrated by photographs.

5. A method is given to determine which maintenance alternative is most cost-effective by calculating the equivalent annual cost for each.

2/ How to Use the Guidelines

Using the Guidelines

If all else fails, read the instructions!
Better still, read the instructions first.

That's what this chapter is for — to tell you how to use the guidelines that appear in the following chapters, to define some basic terms, and to explain why some things are done the way they are. This way, everyone will understand and apply the guidelines in a consistent way and we will move closer to our goal of consistent and comprehensive pavement maintenance.

The Condition Survey

Before explaining what we mean by "condition survey", let's explain what we do not mean...

- We do not mean in any way to trace the performance history of highway pavements.
- Nor do we mean to put maintenance people to work to satisfy a huge data bank somewhere.

The intention of the condition survey is simply to assist field staff to identify and treat each pavement distress discovered during routine inspection. To do this, we have to classify each problem in simple words. We want to know two things: How bad is it? and How big is it?

There are three possible answers to "How bad is it?" They are: SLIGHT, MODERATE and SEVERE. The correct answer may be chosen by simply comparing the distress on the road with the photos of a similar distress in this Guidelines book. The photos clearly show the three stages of severity for each problem.

The question "How big is it?" refers not to the size of the pothole, but rather to what extent the road surface is covered with potholes (or any other kind of distress). This extent of occurrence is called Density and it is broken down into two simple categories: LOCAL and GENERAL.

"Local" is defined as affecting less than 30% of the pavement surface. In other words, the distress is spotted over localized areas only.

A "general" distress is defined as affecting more than 30% of the pavement surface. In other words, the distress occurs more or less evenly over the entire length of the pavement section.

These two classifications of distress density are summarized in the following table.

Classification of Distress Density

Class	Guidelines (Based on percent of surface area in the pavement section affected by distress)
Local:	Less than 30% of pavement surface area is affected by distress; distress is spotted over localized areas only.
General:	More than 30% of pavement surface area is affected by distress; distress is spotted evenly over the entire length of the pavement section.

For example, the maintenance staff member may encounter the situation where there are some potholes located within a short distance of each other and this distance within the evaluation section represents less than 30% of the pavement surface area. Thus, the "density" is said to be "local" (Figure 1).

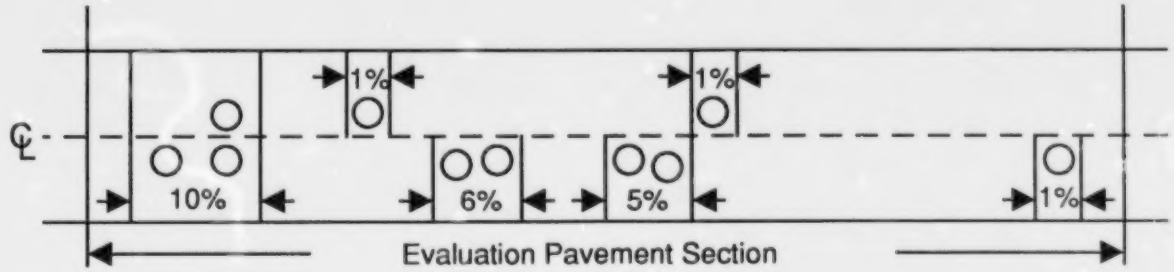


Figure 1/ "Local" Occurrence of Potholes

However, if these potholes are present in clusters covering more than 30% of the pavement surface, it is said to be "general" (Figure 2).

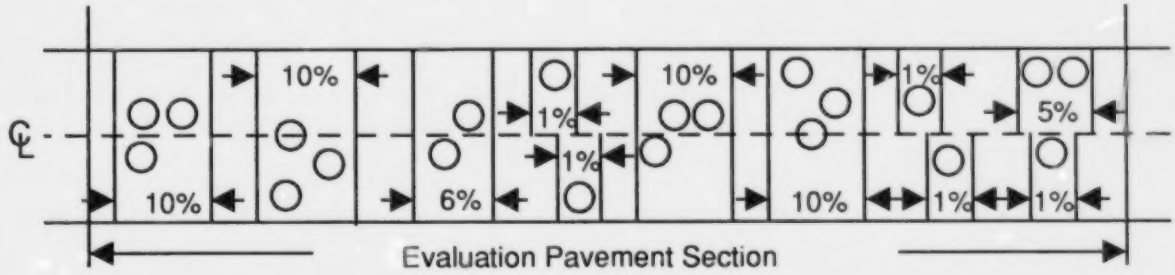


Figure 2/ "General" Occurrence of Potholes

Alternative Treatments

Once a pavement distress has been properly identified and classified according to severity and density, the question arises: What should be done about it?

The answer is provided in the tables printed next to the photos of each type of distress in this book. For each type and classification of distress, maintenance treatments are recommended. These may range from the simple notation "No Action" to several possible alternatives. A brief description of each alternative is given and a Maintenance Performance Standard for each is specified by number. These Performance Standards are printed in full in the last chapter of this book. They give complete details on the recommended treatments (some even include photographs showing how it is done). This information can be used to determine which of the recommended alternatives is the most cost-effective.

Now, clearly, this is a simplified approach to selecting pavement maintenance alternatives. As such, it is neither perfect nor complete. There may be other solutions better suited, there may be some not covered in this book. That's why we offer *guidelines* not rules. We know there is no substitute for the knowledge and experience of the man in the field. But the guidelines offer him valuable assistance by recommending the most likely cost-effective treatments for the vast majority of situations.

Expected Life of Alternative

Obviously, if the safety or minimum comfort level of the travelling public is threatened by a pavement distress, something must be done, *RIGHT AWAY!* In short-term emergencies like this, fixing the problem is all that's important, even if it's just a temporary fix.

In the medium to long term, however, care must be taken to select the maintenance treatment that is most cost-effective. Before you choose an alternative, you have to ask: How long will it last? Again, the answer is provided by the tables in this book.

To compile the tables, we spoke to many MTO people with years of experience in the field and we asked them to estimate the expected service life of each treatment alternative. The "Expected Life" given in the tables is an average of these estimates. We think it's pretty close to being right. If experience shows otherwise, we are prepared to change, but for now, please consider the estimate given to be correct.

Equivalent Annual Cost

Our goal in pavement maintenance is to select the best treatment for each situation. By "best", we usually mean the most cost-effective. The costs of the recommended alternatives must therefore be compared.

This is easily done by using the Maintenance Function Classification code number given in the treatment tables. They correspond to the appropriate Performance Standard in Chapter 7. Simply look it up and you will find complete details on the manpower, equipment, and materials needed for each job and how much can be accomplished in one day's work. From this, you can calculate the unit cost of each recommended treatment alternative...

$$\frac{\text{MANPOWER + EQUIPMENT + MATERIALS}}{\text{ACCOMPLISHMENT PER DAY}} = \text{UNIT COST}$$

Unfortunately, knowing the unit cost isn't enough to make a good comparison because one treatment may cost the same as another but last twice as long. To take this difference in service life into account, you have to average the cost of a repair over the years until you have to do it again. This is called the equivalent annual cost and it is calculated like this...

$$\frac{\text{UNIT COST}}{\text{EXPECTED LIFE OF ALTERNATIVE (YRS)}} = \text{EQUIVALENT ANNUAL COST}$$

The treatment calculated to have the lowest equivalent annual cost is the most cost-effective of the alternatives and should be carried out unless other factors prevail (see Figure 4).

3/ Summary of Procedures for Condition Survey and Treatment Selection

The following steps summarize the procedure to be followed when using this Guidelines book:

Step 1 Drive over the pavement; watch for signs of distress. This will give you an overall impression of the pavement's condition and help to locate areas of distress that need to be looked at more closely.

Step 2 Stop and carefully examine each area of distress. Use the Guidelines to identify each distress, then classify according to severity (slight, moderate, severe) and determine the density of occurrence (local or general).

Step 3 Assess the urgency of the problem. For example, does it threaten the safety of the public?

Step 4 Decide on the priority of each distress. Which one should be repaired first, second, third...?

Step 5 Consult the treatment tables for each type of distress. If more than one method of treatment is recommended, calculate which alternative is most cost-effective (see page 4).

NOTE: Sometimes a distress may be so severe it must be fixed without delay. In such a case the recommended treatment may or may not be practical. It is up to the man in the field to make a decision and perhaps make do with the resources at hand rather than wait until a better treatment can be organized.

Step 6 If a pavement section contains a mixture of several different distresses, the Guidelines may indicate several different treatments. Obviously, there are times when individual attention like this would be silly. So, pick the treatment that is most universal, the one that will fix everything at once.

Step 7 Decide if the selected treatments can be done by a patrol. Confirm your decision (and your choice of treatments) with the District Maintenance Supervisor. If the problem is too big for a patrol to handle, notify the District Office by sending them a Maintenance Needs Report Form (shown in Figure 3). When you fill out the form, make sure you put in all important information.

Step 8 Consider other factors. The treatments recommended in these Guidelines are usually correct but, occasionally, they may be altered in view of special circumstances such as urgency, class of road, availability of men, money, materials, etc... (see Figure 4). It is up to the man in the field to consider such things and make a judgement call on the importance of these "other factors."

Step 9 Stop reading about it; go and DO IT!

Figure 3/ Sample of Maintenance Needs Report

Ministry of Transportation
Ontario

HIGHWAY MAINTENANCE
NEEDS REPORT

Date _____

LOCATION

District _____ Patrol _____ Highway _____

Surface ☐ Lane _____ Shoulder ☐ Roadside ☐ Drainage ☐

Bridge ☐ Safety Barrier ☐ Sign ☐ Fence ☐ Other ☐

At _____

CONDITION

Description _____

Severity _____

Density _____

PROBABLE CAUSES

RECOMMENDED REPAIRS

Include details of quantity estimates, suggested year of work, life expectancy of repair, etc.

PREVIOUS REPAIRS

Identify corrective treatment performed to date by Patrol or others...

_____
Signature of Patrolman

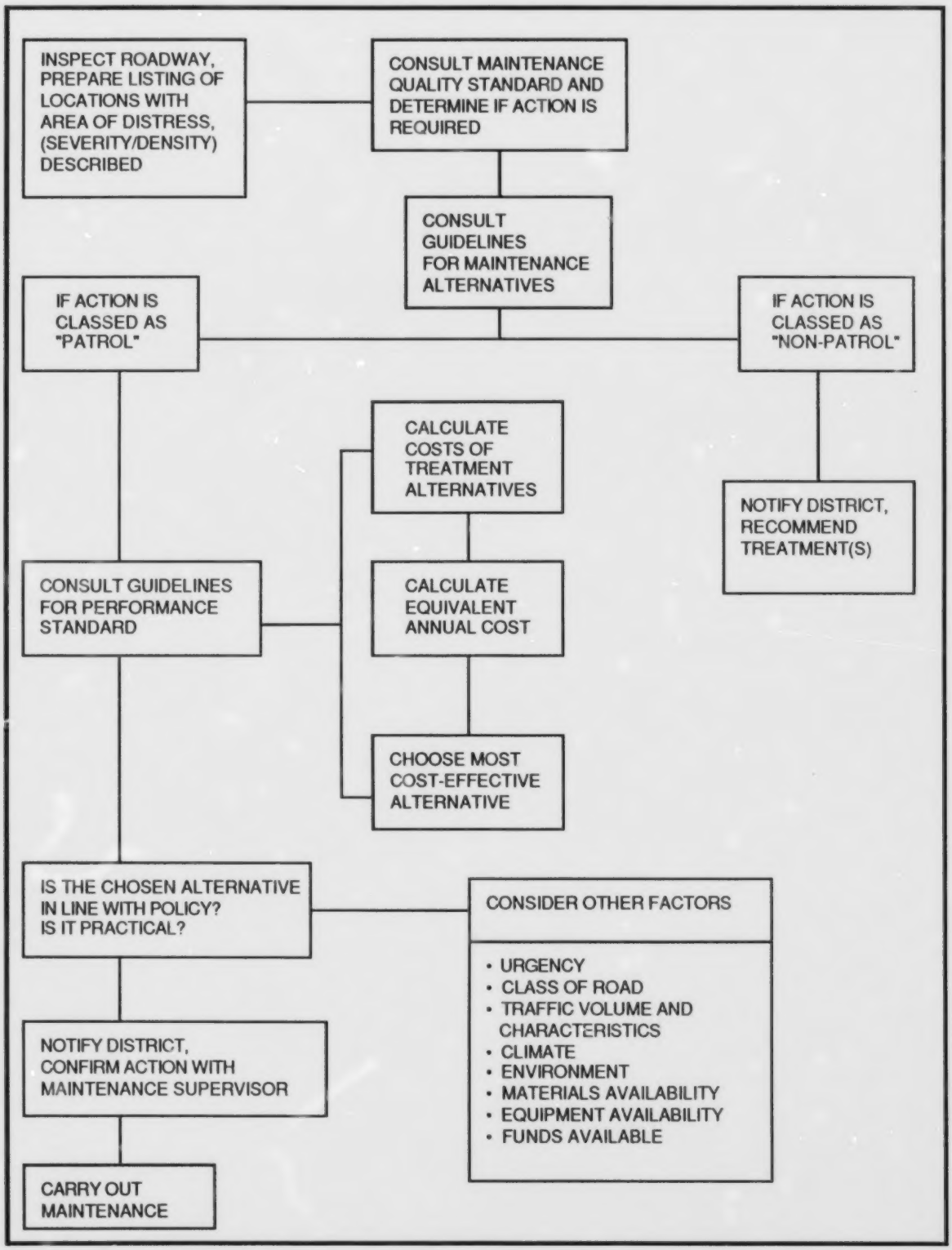
DISTRIBUTION: copies 1 & 3 to District Maintenance Office; Copy 2 retain in Patrol Office

ACTION TAKEN

Return copy 3 to Patrol Office.

_____
Signature of District Engineer

Figure 4/ Procedures for Maintenance Staff


INSPECT ROADWAY, PREPARE LISTING OF LOCATIONS WITH AREA OF DISTRESS, (SEVERITY/DENSITY) DESCRIBED
CONSULT MAINTENANCE QUALITY STANDARD AND DETERMINE IF ACTION IS REQUIRED
CONSULT GUIDELINES FOR MAINTENANCE ALTERNATIVES
IF ACTION IS CLASSED AS "PATROL"
IF ACTION IS CLASSED AS "NON-PATROL"
CALCULATE COSTS OF TREATMENT ALTERNATIVES
NOTIFY DISTRICT, RECOMMEND TREATMENT(S)
CONSULT GUIDELINES FOR PERFORMANCE STANDARD
CALCULATE EQUIVALENT ANNUAL COST
CHOOSE MOST COST-EFFECTIVE ALTERNATIVE
IS THE CHOSEN ALTERNATIVE IN LINE WITH POLICY? IS IT PRACTICAL?
CONSIDER OTHER FACTORS
• URGENCY
• CLASS OF ROAD
• TRAFFIC VOLUME AND CHARACTERISTICS
• CLIMATE
• ENVIRONMENT
• MATERIALS AVAILABILITY
• EQUIPMENT AVAILABILITY
• FUNDS AVAILABLE
NOTIFY DISTRICT, CONFIRM ACTION WITH MAINTENANCE SUPERVISOR
CARRY OUT MAINTENANCE

4/ Distress and Maintenance Treatments Flexible Pavement

4.1 / Cracking

Longitudinal Cracking

Transverse Cracking

Alligator Cracking

Map Cracking

Progressive Edge Cracking/Edge Breaking

Longitudinal Cracking

Description:

Cracks follow a course approximately parallel to the direction of travel and are situated at or near the centre of the wheel track, centre line, mid-lane, pavement edges, etc.

Possible Causes:

1. Traffic action (loading) combined with weak pavement.
2. Poor construction equipment and/or technique.
3. Environment and climatic conditions (frost action, moisture changes, etc.).
4. Poor drainage conditions at pavement and shoulder.
5. Natural shrinkage caused by very low temperatures.
6. High temperature susceptibility of asphalt cement binder in asphalt mixes.
7. Reflection cracks.

Severity:

Class	Guidelines (Based on crack width and its condition)
Slight	Single crack with opening less than 10 mm.
Moderate	Single crack with opening 10 mm to 20 mm, or multiple cracks although opening is less than 10 mm.
Severe	Single crack with opening more than 20 mm, or multiple cracks with spalling beginning to develop.

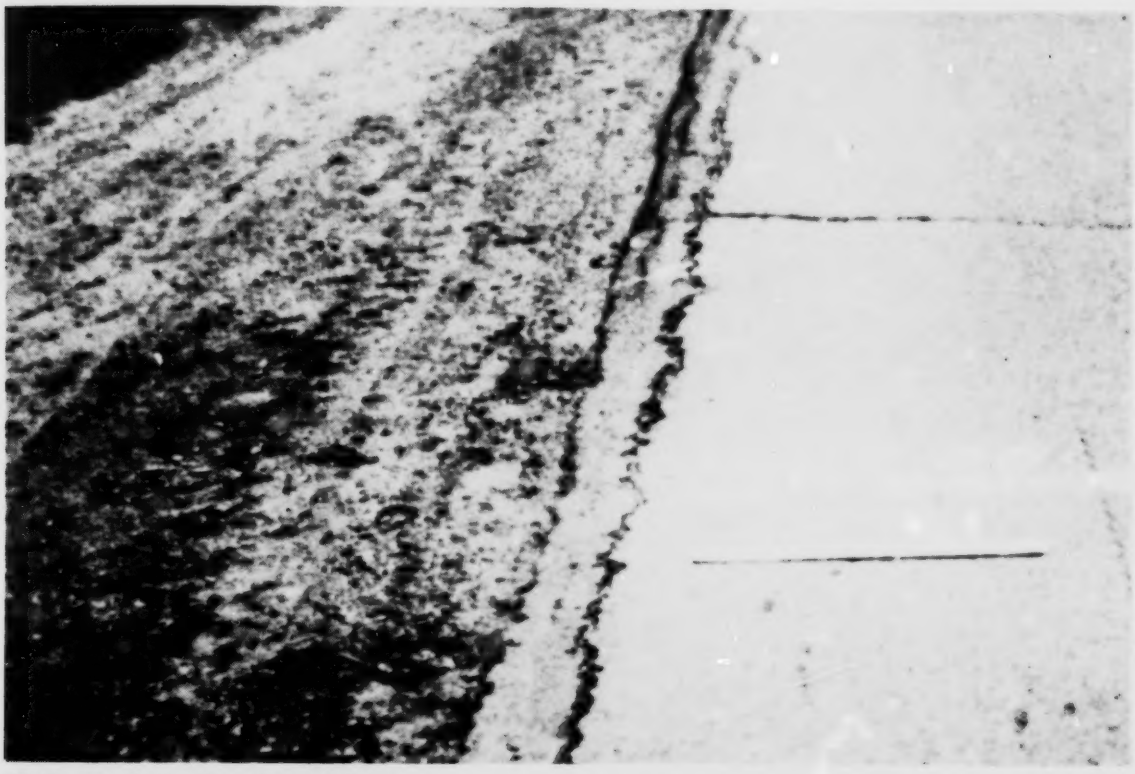
Density:

Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.

Slight Longitudinal Mid-lane Crack

Slight Centre Line Crack

Moderate Multiple Longitudinal Wheel Track Cracking



Moderate Pavement Edge Crack

Severe Longitudinal Meandering Crack

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• No action if cracks less than 6 mm for asphalt pavement • Rout and Seal if cracks are greater than 3 mm on asphalt pavement with concrete or soil cement base		1005	5+
	General	• No action if cracks less than 3 mm • Rout and Seal if cracks greater than 3 mm		1005	5+
Moderate	Local	• Rout and Seal single cracks • Rout and Seal multiple cracks		1005 1005	5+ 5+
	General	• Rout and Seal single cracks • Chip Seal multiple cracks	1004	1005	5+ 2+
Severe	Local	• Rout and Seal single cracks • Chip Seal multiple cracks	1004	1005	5+ 2+
	General	• Notify District Office			

Transverse Cracking

Description:

Cracks which follow a course approximately at right angles to the pavement centre line. Full transverse cracks tend to be regularly spread along the length of the road; half transverse and part transverse cracks occur at shorter intermediate distances.

Possible Causes:

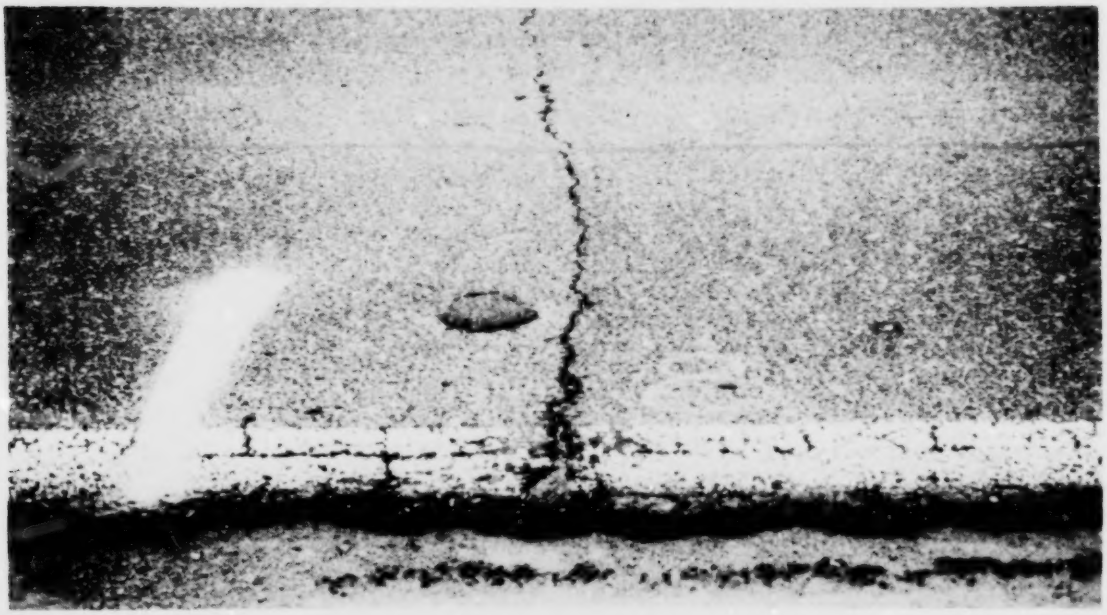
1. Environment and climatic conditions (frost action, moisture changes, etc.)
2. Natural shrinkage caused by very low temperature.
3. High temperature susceptibility of asphalt cement binder in asphalt mixes.
4. Reflection cracks.

Severity:

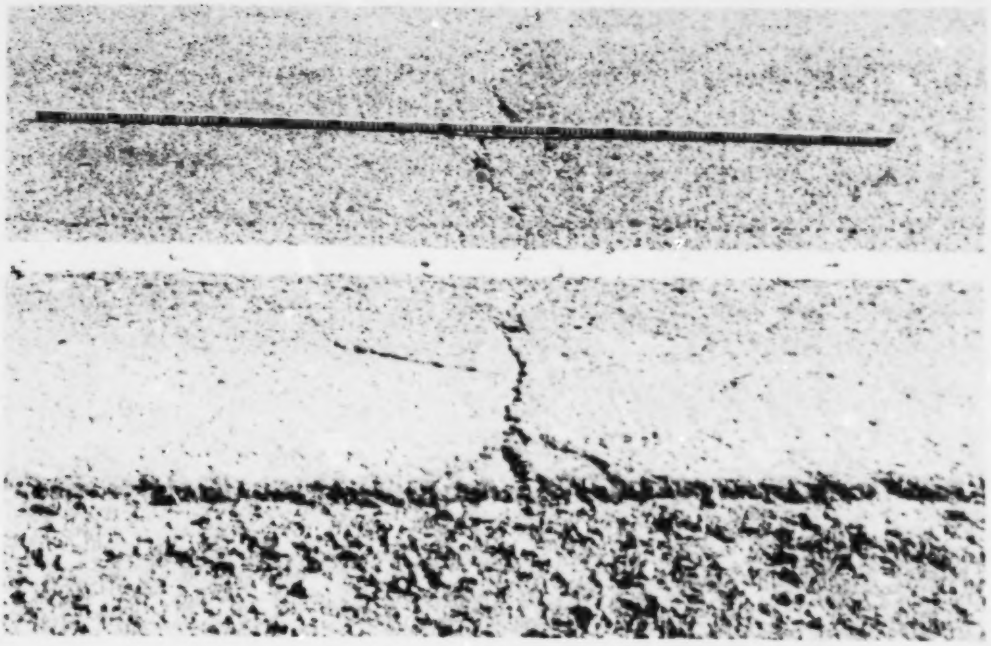
Class	Guidelines (Based on crack width and its condition)
Slight	Single crack with opening less than 10 mm .
Moderate	Single crack with opening 10 mm to 20 mm with or without cupping or lipping or multiple transverse cracking with or without cupping or lipping although crack openings may be less than 10 mm.
Severe	Single crack with opening greater than 20 mm with or without cupping or lipping; or multiple transverse cracking with cupping or lipping or spelling beginning to develop.

Density:

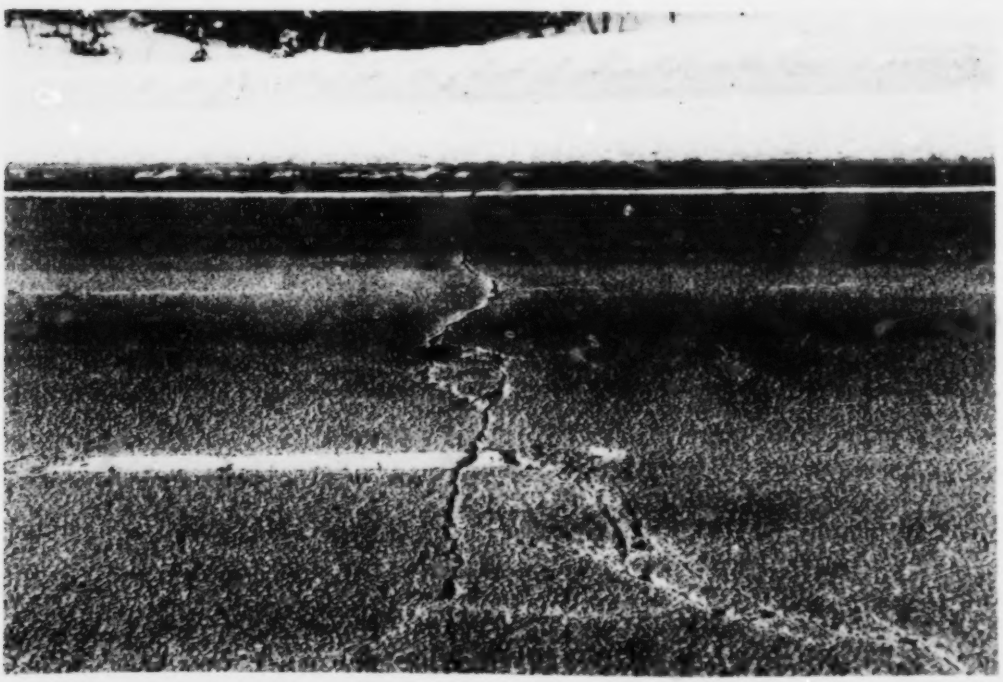
Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement surface.



Slight Transverse Crack



Moderate Transverse Crack with Secondary Cracks and Cupping



Severe Transverse Crack with Secondary Cracks and Spalling

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• No action if cracks less than 6 mm for asphalt pavement • Rout and Seal if cracks are on asphalt pavement over concrete or soil cement base		1005	5+
	General	• No action if cracks less than 3 mm • Rout and Seal if cracks greater than 3 mm		1005	5+
Moderate	Local	• Rout and Seal single cracks • Rout and Seal single cracks with cupping or lipping		1005 1005	5+ 5+
	General	• Rout and Seal single cracks with or without cupping or lipping • Chip Seal multiple cracks • No action, but notify District Office	1004	1005	5+ 2+
Severe	Local	• Rout and Seal single cracks if no cupping or lipping		1005	5+
	General	• No action, but notify District Office			

Cracking

Alligator Cracking

Description:

Cracks form a network of multi-sided (polygon) blocks resembling the skin of an alligator. The block size can range from 50 mm to 100 mm to about 500 mm. The alligatored area may or may not be accompanied by distortion in the form of depression, and may occur anywhere on the pavement surface.

Possible Causes:

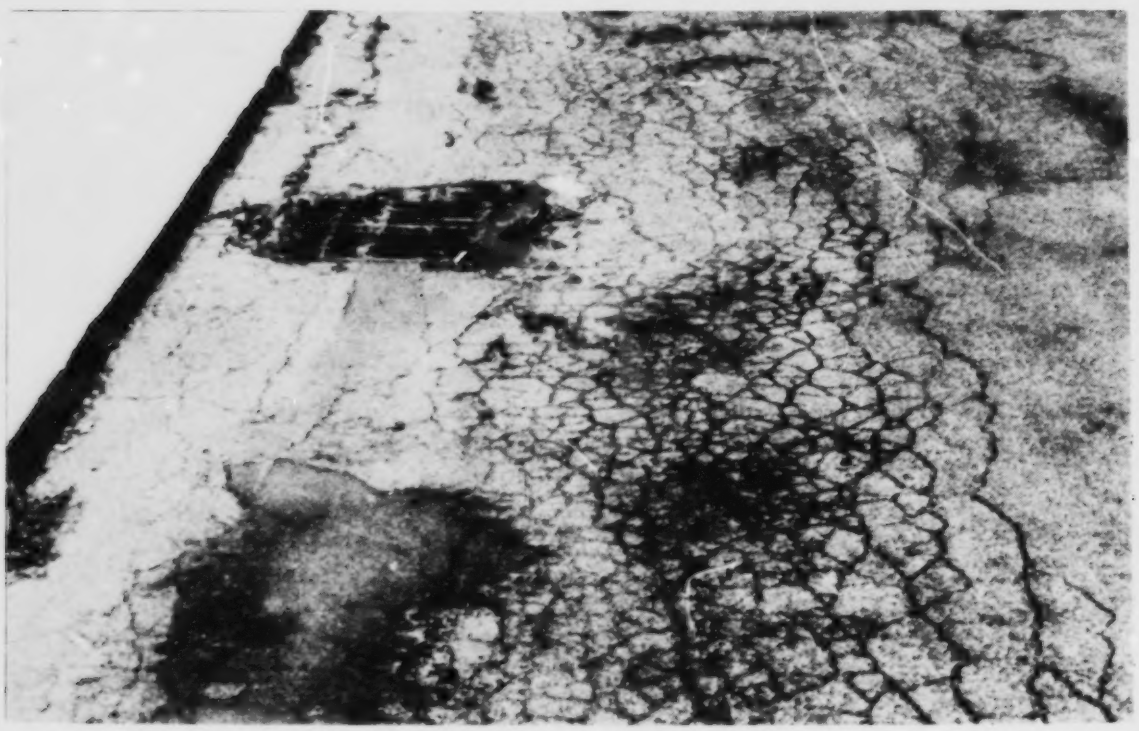
1. Insufficient pavement strength.
2. Poor base drainage and stiff or brittle asphalt mix at cold temperature.

Severity:

Class	Guidelines (Based on appearance and surface distortion)
Slight	Alligator pattern established with corners of polygon blocks fracturing.
Moderate	Alligator pattern established with spalling of polygon blocks.
Severe	Polygon blocks begin to lift; may or may not involve potholes.

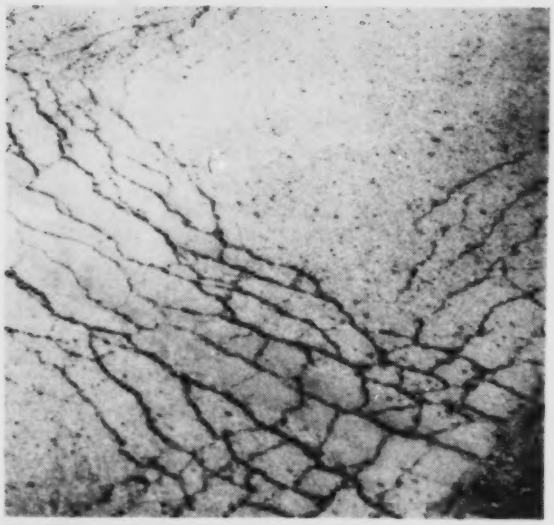
Density:

Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.

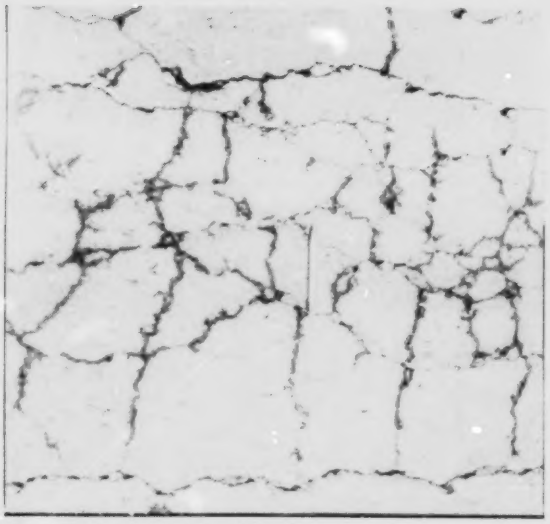


Severe Alligator Crack

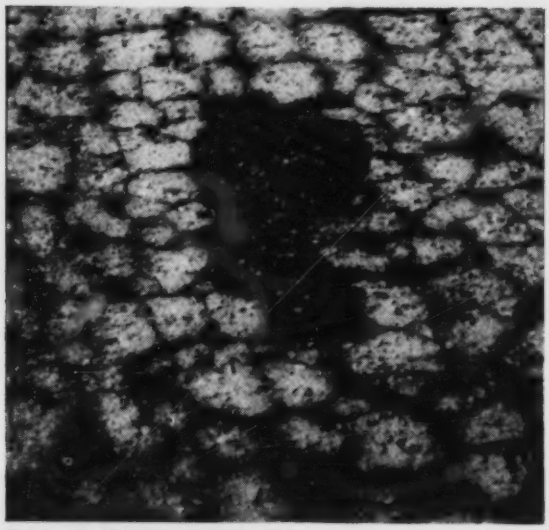
Slight Alligator Cracking



Moderate Alligator Cracking



Moderate Alligator Crack



Severe Alligator Crack

Severe Alligator Cracking

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• Chip Seal • No Action	1004		1
	General	• Chip Seal • No Action, but monitor closely for future development	1004		1
Moderate	Local	• Chip Seal • Cold-Mix Patch • Hot-Mix Patch	1004 1001 1001 1002	 1002	1 2 3 4
	General	• Hot-Mix Patch for Multi-lanes • Same as above, but notify District Office and maintain close monitoring		1002	4
Severe	Local	• Cold-Mix Patch • Hot-Mix Patch • Excavate, granular and hot-mix patch • Improve drainage (additional)	1001 1001 1002 1002 *	 1002 1002 *	0.5 3 4 7
	General	• Hot-Mix patch over selected areas for safety reasons and notify District Office for further action • Mulching for pavement with AADT less than 2000 • Granular lift and Surface Treatment for pavement with AADT less than 2000 • No Action, but notify District Office	1002	1002 1014 1017	3 3 4

** Contract only*

Map Cracking

Description:

Crack runs randomly along the pavement surface, sometimes in a serpentine manner. The crack appears to have transverse and longitudinal cracks combined to form a map.

Possible Causes:

1. Swelling or shrinkage.
2. Frost action.
3. Aging of asphaltic concrete.

Severity:

Class	Guidelines (Based on crack width and its condition)
Slight	Map pattern established with crack opening less than 10 mm.
Moderate	Map pattern established with crack opening 10 mm to 20 mm, multiple cracking may begin to develop.
Severe	Map pattern established with crack opening greater than 20 mm, multiple cracking developed.

Density:

Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.

Map Cracking

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• Rout and Seal • No Action		1005	5+
	General	• Rout and Seal • No Action		1005	5+
Moderate	Local	• No Action for highways with AADT less than 2000 • Notify District Office if highways have AADT greater than 2000 • Rout and Seal		1005	5+
	General	• Sand Seal for highways with AADT less than 2000		1017*	2
		• Surface Treatment for highways with AADT less than 2000		1017	3
		• Hot-Mix Patch for highways with AADT greater than 2000 (Must notify District Office for further investigative action before any work carried out)	1002	1002	4
Severe	Local	• Sand Seal for highways with AADT less than 2000 and notify District Office		1017*	1
		• Surface Treatment for highways with AADT less than 2000 and notify District Office		1017	2
		• Hot-Mix Patch for Highways with AADT greater than 2000 and notify District Office	1002	1002	4
	General	• Surface Treatment for highways with AADT less than 2000		1017	2
		• Single Course Hot-Mix Resurfacing for highways with AADT greater than 2000		****	6
		• No Action, but notify District Office except Hot-Mix Patch over selected areas.	1002	1002	4

**** *Non-routine maintenance task; contract only.*

Cracking

Progressive Edge Cracking/Edge Breaking

Description:

Cracks begin parallel to and within 300 mm of the pavement edge; cracking is either a fairly continuous straight crack or consists of crescent-shaped cracks in wave-formation. Progressive edge cracking will gradually encroach into the outer-wheel tracks, through the middle of the lane, and may even spread across to the centre line. Edge breaking occurs with or without cracks; it generally occurs in mulch or surface-treatment types of pavement surfaces.

Possible Causes:

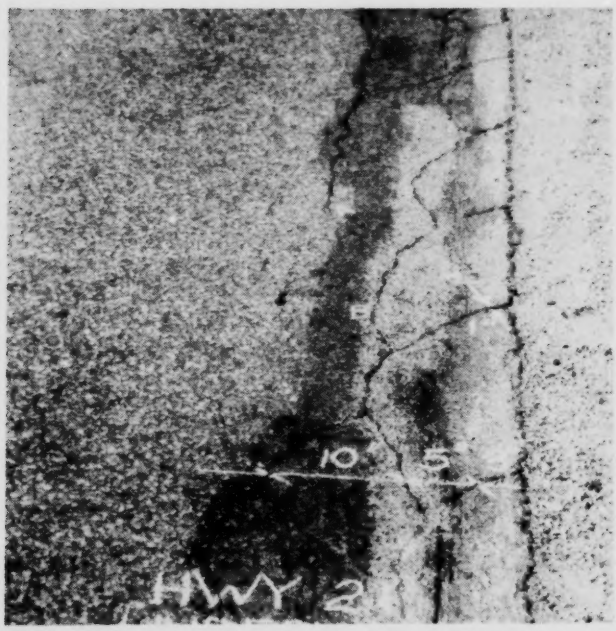
1. Frost action.
2. Insufficient pavement strength or excessive loading at the pavement edge.
3. Poor drainage at pavement edge and shoulder.
4. Inadequate pavement width forces traffic too close to pavement edge.

Severity:

Class	Guidelines (Based on extent to which cracks have multiplied and stage of development)
Slight	Less than 600 mm from pavement edge; single or two parallel cracks.
Moderate	Extending over 600 mm, but less than 900 mm from pavement edge; multiple cracks with connecting cracks.
Severe	Extending more than 900 mm from pavement edge; alligatoring of pavement occurs at and near pavement edge.

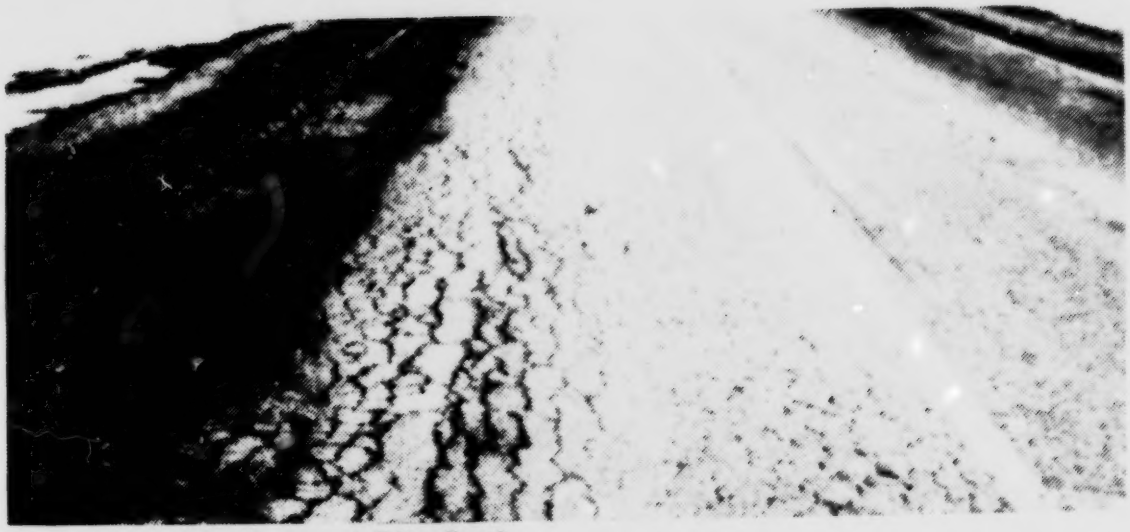
Density:

Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.

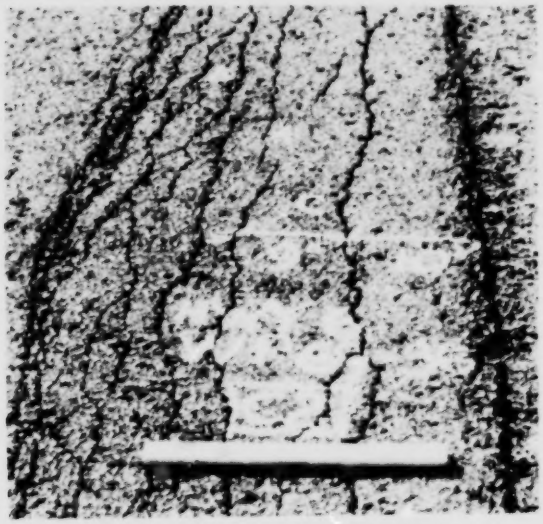


Slight Pavement Edge Crack (Wave Formation)

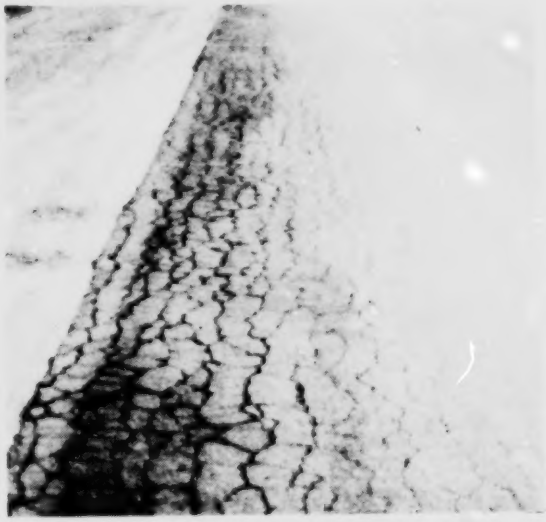
Moderate Progressive Edge Cracking



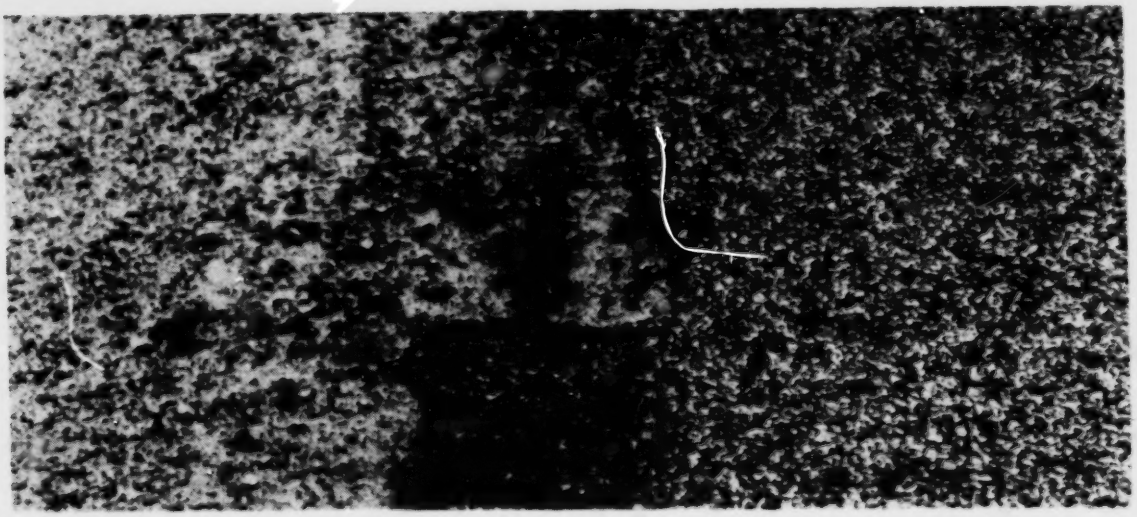
Severe Progressive Pavement Edge Crack



Moderate Progressive Edge Cracking



Severe Progressive Pavement Edge Crack
(Note Alligatoring of pavement already occurs)



Moderate Pavement Edge Breaking

Severe Pavement Edge Breaking

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• No Action			
	General	• No Action, but monitor for development			
Moderate	Local	• Spray Patch (Chip Seal) • Cold-Mix Edge Patch*	1004 1001		1 2
	General	• Spray Patch (Chip Seal) • Cold-Mix Edge Patch* • Hot-Mix Quarter Patch • Improve shoulder drainage (additional) • Notify District Office	1004 1001 1002	 1002 **	1 2
Severe	Local	• Spray Patch (Chip Seal) • Cold-Mix Edge Patch* • Hot-Mix Quarter Patch • Cold-Mix Edge Patch*	1004 1001 1001 1002 1001		1 2 3 2
	General	• Hot-Mix Quarter Patch • Hot-Mix full width patch • Single Course Hot-Mix Resurfacing • Improve shoulder drainage (additional) • Spot patch with Hot-Mix and notify District Office	1002 1002 1001	1002 1002 **** ** 1001	2 3 4 2

** This treatment is to be used only on mulch and surface treatment types of pavement surface.*
*** Contract only.*
***** Non-routine maintenance task; contract only.*

4.2/ Surface Distortions

Surface Distortions

Severe Frost-related Bump

Excessive Crown

Sagging, Dishing, Depression, Settlement

Surface Distortions

Description:

Any deviation of the pavement surface from its original shape (other than described for rippling, shoving and rutting). Generally, these distortions result from settlement, slope failure, volume changes due to moisture and frost heaving, and from residual effects of frost heaving accumulating after each winter. The resulting deformation may take the form of dishing, bumps, dips, tenting or stepping at cracks, all of which give rise to pitch and roll in a moving vehicle.

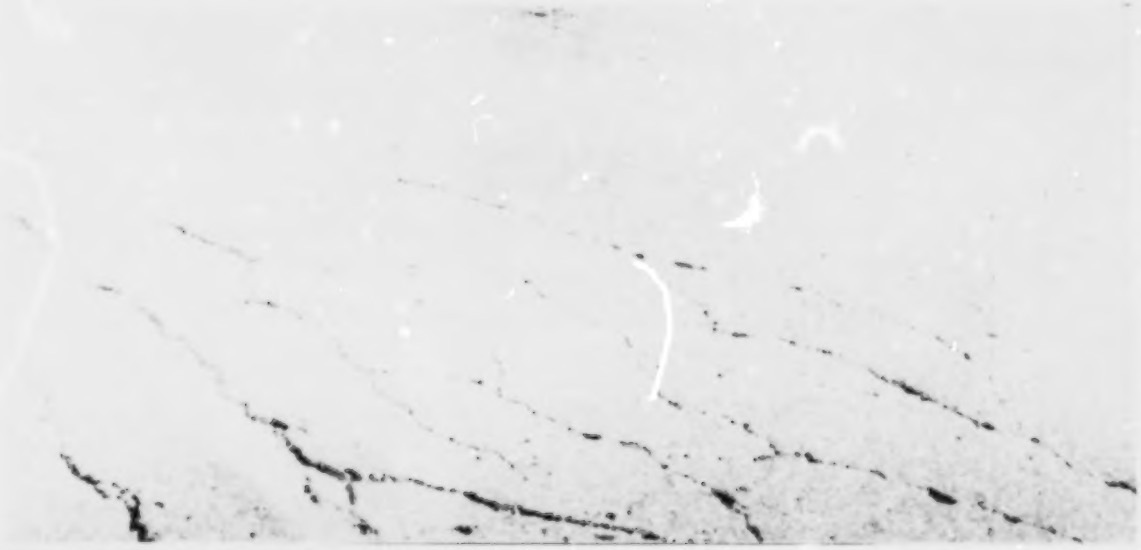
Possible Causes:

1. Differential frost heave in poorly drained cuts and transitions.
2. Differential frost heave at pavement edges or road centre.
3. Reverse differential frost heave at culverts.
4. Differential settlement of subgrade or base materials.
5. Lack of subgrade support.
6. Embankment slope failure.

Severity:

Class	Guidelines (Based on personal experience of the interaction between vehicle and pavement surface distortion)
Slight	Swaying or jarring motion, but good control of vehicle still present for driver.
Moderate	Fair control of vehicle when driven over pavement.
Severe	Poor control of vehicle when driven over pavement; driver always has to anticipate distortion ahead.

Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.



Severe Bump from Frost Heaving

Severe Frost-Related Bump

Severe Frost-related Bump

Treatments

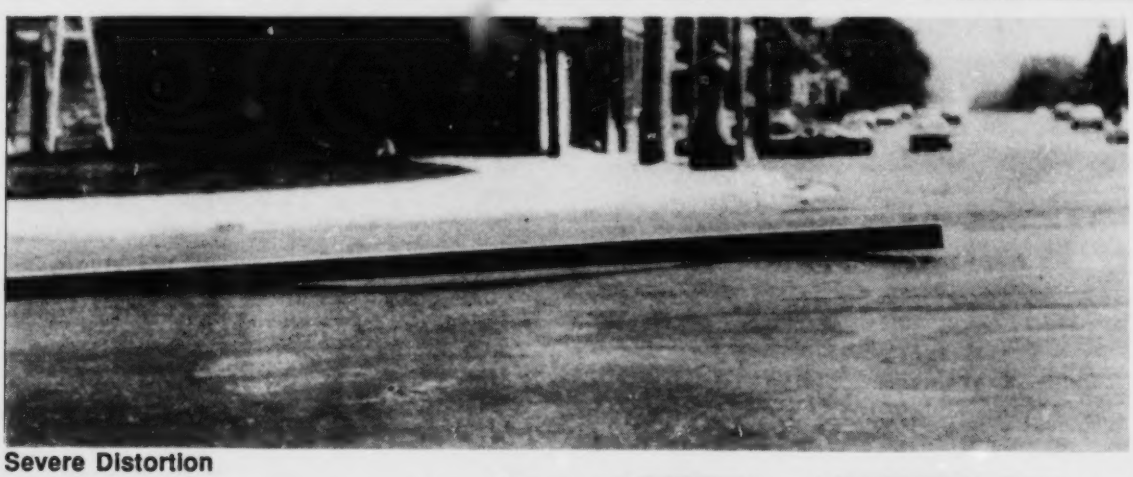
Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• No Action			
Moderate	Local	• Cold-Mix Patch • Hot-Mix Patch	1001 1001 1002		0.5 2 2
Severe	Local	• Cold-Mix Patch and notify District Office • Hot-Mix Patch and notify District Office • Heater Planing/Scarifying/ Leveling • Cold Planing/Milling or Burning • Cold-Mix Patch and notify District Office for future action (e.g., excavate and back-fill with approved granular materials and hot-mix resurfacing in the spring)	1001 1002 1001 (1020)	 1090 (H) 1006 1001 (1020)	0.5 2 0.5

Excessive Crown

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• No Action			
	General	• No Action, but monitor for future development			
Moderate	Local	• No Action			
	General	• No Action, but notify District Office			
Severe	Local	• Cold-Mix Patch full width or quarter width (quarter patch should be used only on highways with AADT less than 2000)	1002		0.5
		• Hot-Mix Patch full width	1002	1002	6
		• Hot-Mix Patch quarter width	1002		3
	General	• Cold-Mix Patch full width on selected areas and notify District Office	1002		2
		• Cold-Mix patch quarter width on selected areas and notify District Office (use only on highways with AADT less than 2000)	1002		1
		• Hot-Mix Patch full width or selected areas and notify District Office	1002	1002	4
		• Hot-Mix Patch quarter width on selected areas and notify District Office (do not use on multi-lane highways)	1002		3

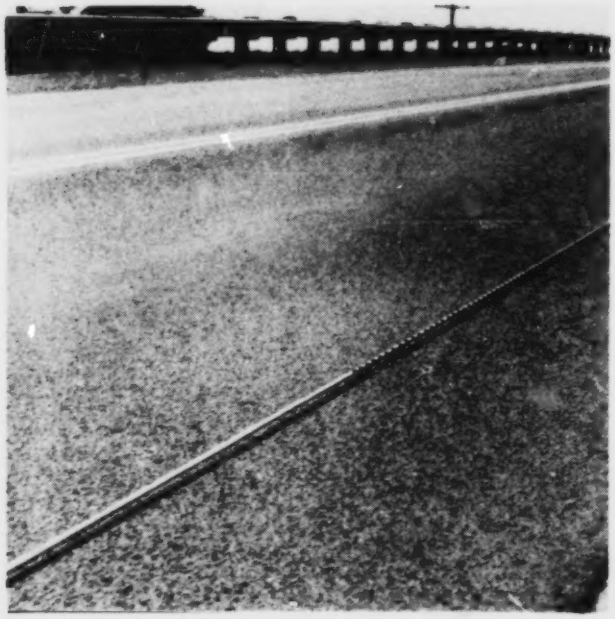
Sagging, Dishing, Depression, Settlement



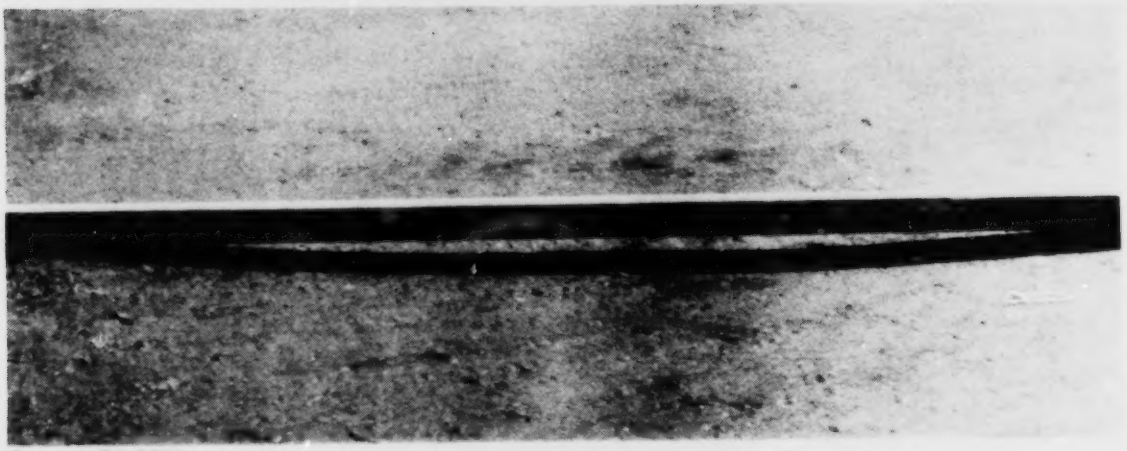
Severe Distortion

Severe Depression

Slippage Settlement



Sagging



Severe Dishing

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• No Action			
	General	• No Action			
Moderate	Local	• No Action			
	General	• Cold-Mix Patch and notify District Office • Hot-Mix Patch and notify District Office	1001 1001 1002	 1002	0.5 2
Severe	Local	• Cold-Mix Patch • Hot-Mix Patch	1001 1002 1001	 1002	0.5 2
	General	• Cold-Mix Patch and notify District Office • Hot-Mix Patch and notify District Office	1001 1001 1002	 1002	0.5 2.0

4.3 / Surface Defects

- Flushing
- Potholes
- Ravelling/Segregation
- Rippling/Shoving
- Slippery Surface
- Wheel Track Rutting

Flushing

Description: Free asphalt migrating upwards to the pavement surface. Most likely to occur in the wheel tracks, especially during hot weather.

Possible Causes:

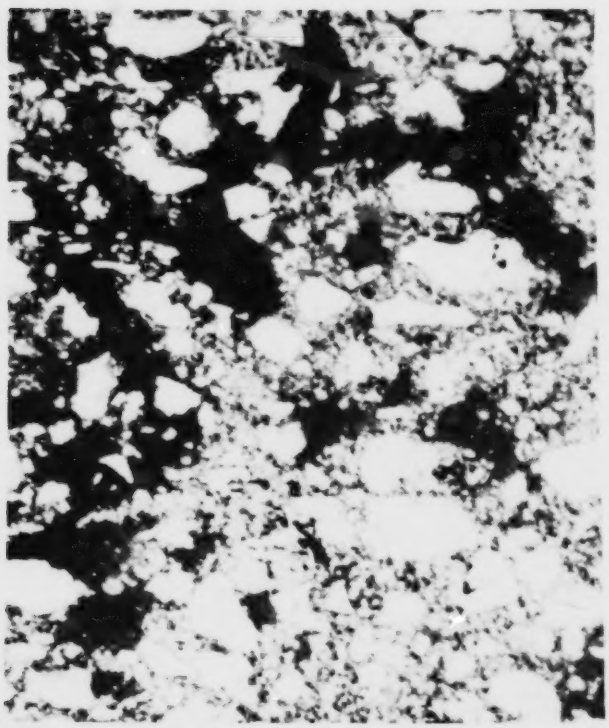
1. Too much asphalt in mix; excess asphalt is forced to the pavement surface by traffic action.
2. Paving over flushed pavement with new asphalt without treating the flushed surface.
3. Paving over excess primed surfaces.

Severity:

Class	Guidelines (Based on observation)
Slight	Colouring of pavement surface visible (interconnected veining).
Moderate	Distinctive appearance (with excess asphalt already free).
Severe	Free asphalt gives the pavement surface a wet look; tire marks and tracking are evident; tire noise can be heard.

Density:

Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.



Slight Flushing

Moderate Flushing

Severe Flushing

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local General	• No Action • No Action			
Moderate	Local General	• No Action • No Action, but notify District Office of the problem situation			
Severe	Local	• Blotting with hot sand • Burn and Seal with fine aggregates for highways with AADT less than 2000 • Burn and Hot-Mix Patch for highways with AADT greater than 2000	1090 (B) 1090 (B) 1090 (B) 1001	1090 (B) 1090 (B) 1090 (B) 1002	 2 4
	General	• Burn and Sand Seal or Chip Seal for highways with AADT less than 2000 • Burn and Single Course Hot-Mix resurfacing for highways with AADT greater than 2000 • Burn and Hot-Mix patch selected areas and notify District Office of the problem situation	 1090 (B) 1001	1090 (B) 1017 1090 (B) 1002* 1090 (B) 1002	2 6 4

** Contract only*

Surface Defects

Potholes

Description: Bowl-shaped holes in pavement; can be unrelated to other surface defects or a direct result of other defects such as ravelling, alligator cracking, etc.

Possible Causes:

1. Poor construction technique and poor quality control.
2. Poor aggregates in pavement.
3. Result of other defects (ravelling, cracking, alligator cracking, etc.)

Severity:

Class	Guidelines (Based on observation)
Slight	Less than 80 mm wide and shallow in depth.
Moderate	80 mm to 300 mm wide and usually more than 50 mm deep.
Severe	More than 300 mm wide and usually more than 100 mm deep.

Density:

Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.

Moderate Pothole

Severe Pothole

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• Spray Patch (Chip Seal)	1004		1.5
	General	• Spray Patch (Chip Seal)	1004		1.5
Moderate	Local	• Cold-Mix Patch	1001		1
		• Hot-Mix Patch	1001 1002		2
	General	• Cold-Mix Patch	1001		1
		• Hot-Mix Patch	1001 1002		2
Severe	Local	• Cold-Mix Patch	1001		1
		• Hot-Mix Patch	1001 1002		2
	General	• Cold-Mix Patch with Sand Seal for highways with AADT less than 2000		1001 1017	1.5
		• Cold-Mix Patch with surface treatment for highways with AADT less than 2000		1017 1001	2
		• Cold-Mix Patch and notify District Office	1001		1
		• Mulching over existing highway for highways with AADT less than 2000		1014	3.5
		• Granular Lift and Surface Treatment for highways with AADT less than 2000		1017	4
		• Hot-Mix Patch and Surface Treatment for highways with AADT less than 2000		1002 1017	3
		• Hot-Mix Patch and Single Course Hot-Mix Resurfacing for highways with AADT greater than 2000		****	6
		• Hot-Mix Patch and notify District Office	1002	1002	2

**** *Non-routine maintenance task; contract only.*

Ravelling/Segregation

Description:

Progressive loss of pavement material from surface downward. Pavement surface looks as though it is breaking up into small pieces like a peeling sunburn. Ravelling can occur over the entire surface, but the wheel tracks are generally the worst areas because of the traffic action.

Possible Causes:

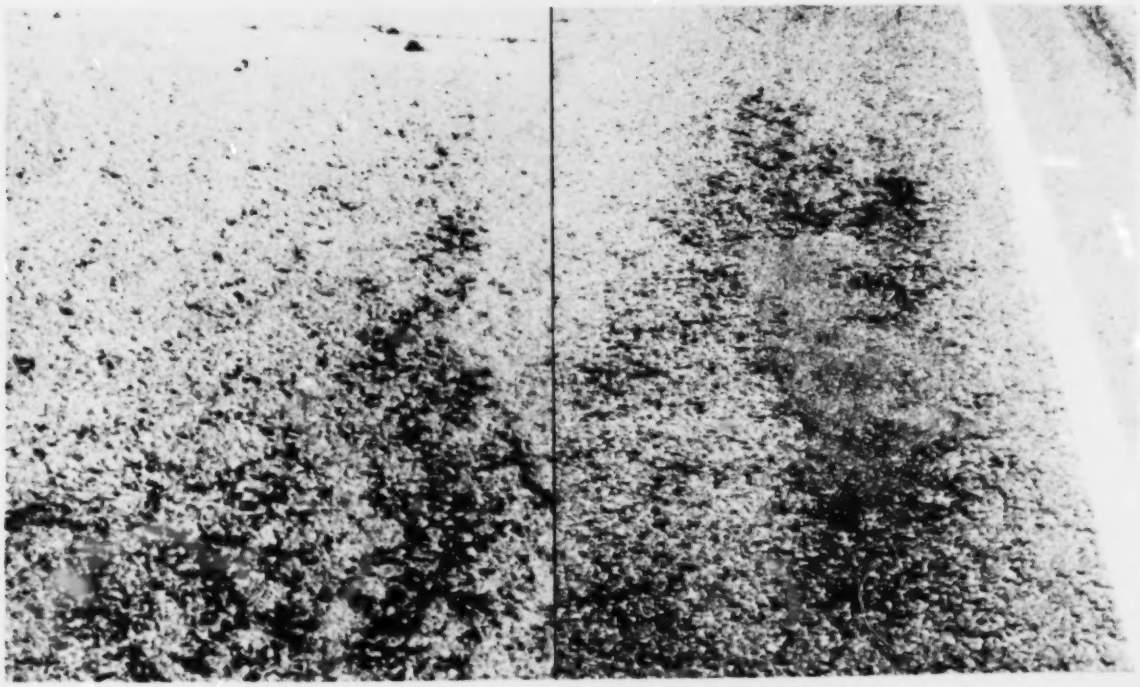
1. Poor construction technique and poor quality control.
2. Asphalt hardening due to aging.
3. Traffic action on a weak surface.

Severity:

Class	Guidelines (Based on observation)
Slight	Noticeable loss of pavement material.
Moderate	Shallow disintegration of pavement surface; an open textured look.
Severe	Shallow disintegration of pavement surface with small potholes, very open texture with loose materials.

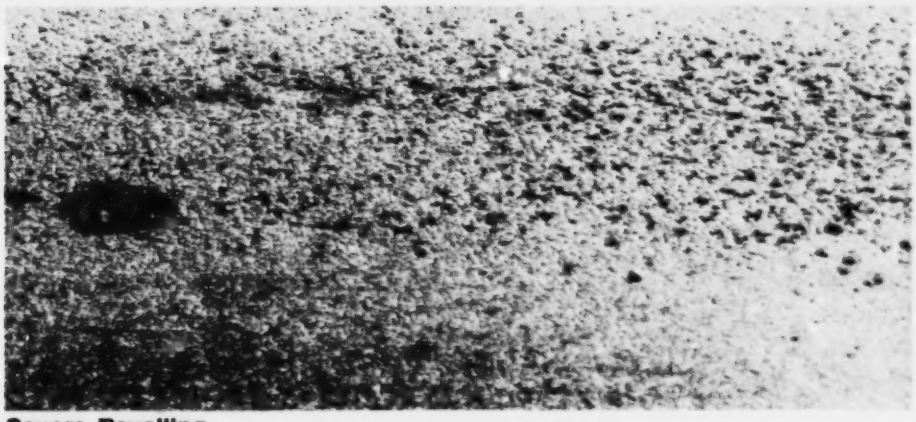
Density:

Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.



Slight Ravelling

Moderate Ravelling



Severe Ravelling

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• No Action			
	General	• No Action			
Moderate	Local	• Spray Patch (Chip Seal)	1004		2
	General	• Sand Seal for AADT less than 2000		1017*	1.5
		• Surface Treatment for highways with AADT less than 2000		1017	3
		• Hot Mix Patch selected areas and monitor for future deterioration if highway has AADT greater than 2000	1001 1002	1002	4
		• No Action but inform District Office of the problem situation			
Severe	Local	• Spray Patch (Chip Seal)	1004		1
		• Hot Mix Patch	1001 1002	1002	4
	General	• Surface Treatment for highways with AADT less than 2000		1017	2.5
		• Single Course Hot- Mix Resurfacing for highways with AADT greater than 2000		****	7
		• Hot Mix Patch selected areas and notify District Office of the problem situation	1001 1002	1002	3

**** *Non-routine maintenance task; contract only.*

Surface Defects

Rippling/Shoving

Description: Regular transverse undulations in the pavement surface consisting of closely spaced alternate valleys and crests; unevenness of pavement surface caused by traffic action moving surface mat forward, backward or sideways.

Possible Causes:

1. Poor material design and construction technique; poor quality control.
2. Traffic action, such as stop and start at intersections.

Severity:

Class	Guidelines (Based on observation and effect on rideability)
Slight	Noticeable
Moderate	Rough ride
Severe	Very rough ride; loss of control of vehicle may result.

Density:

Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.

Severe Rippling

Severe Shoving (Caused by Horizontal Thrust of Wheels)

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• No Action			
	General	• Monitor for future consideration			
Moderate	Local	• Cold Mix Patch	1001		1
		• Hot Mix Patch	1001 1002		2.5
	General	• Notify District Office and Cold Mix Patch	1001		1
		• Hot Mix Patch	1001 1002	1002	2.5
		• Cold Planning/Milling		1006	1
		• Heater Planning / Scarifying / Leveling		1090 (H)	1
Severe	Local	• Cold Mix Patch	1001		0.5
		• Hot Mix Patch	1001/1002	1001/1002	2
		• Cold Planning/Milling		1006	
		• Heater Planning / Scarifying / Leveling		1090 (H)	
	General	• Mulching for highways with AADT less than 2000		1014	3
		• Granular Lift and Surface Treatment for highways with AADT less than 2000		1017	3
		• Hot Mix Patch only for highways with AADT less than 2000		1001 1002	4
		• Hot Mix Patch and One Course of Hot Mix Resurfacing for highways with AADT greater than 2000		****	6
		• Hot Mix Patch only and notify District Office for highways with AADT greater than 2000	1001 1002	1002	2
		• Notify District Office only			

**** *Non-routine maintenance task; contract only.*

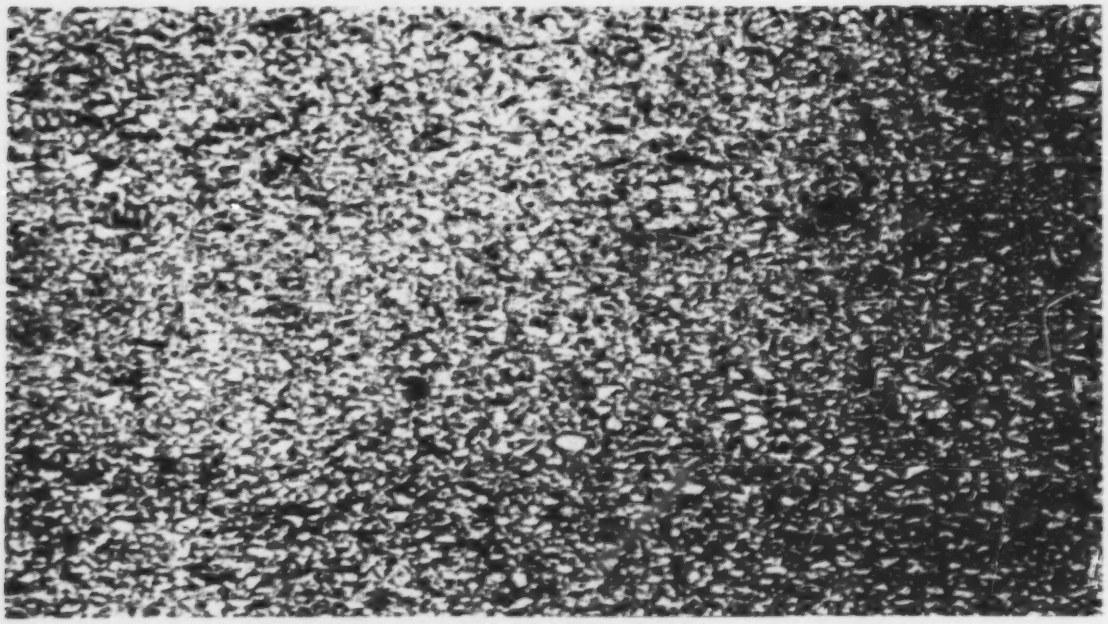
Slippery Surface

Description: Shining surface from free asphalt; or polished coarse aggregates evident in the pavement surface.

Possible Causes:
1. Free asphalt from flushing.
2. Coarse aggregates, which are easily polished under traffic.

Severity: If slippery pavement surface is suspected, notify or consult District Office immediately.

Slipperiness, Flexible Pavement (Mirror-polished Surface)



Slipperiness, Flexible Pavement (Flat and Polished Stones)

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
		If any areas of pavement surface are suspected of being slippery, notify the District Office immediately of the problem situation, and meanwhile maintain monitoring of the suspected areas			

Wheel Track Rutting

Description: Longitudinal depression left in the wheel tracks after repeated load application. It results from compaction under load combined with a shoving sideways of pavement material. Wheel track rutting can appear as single rut or double ruts.

Possible Causes:

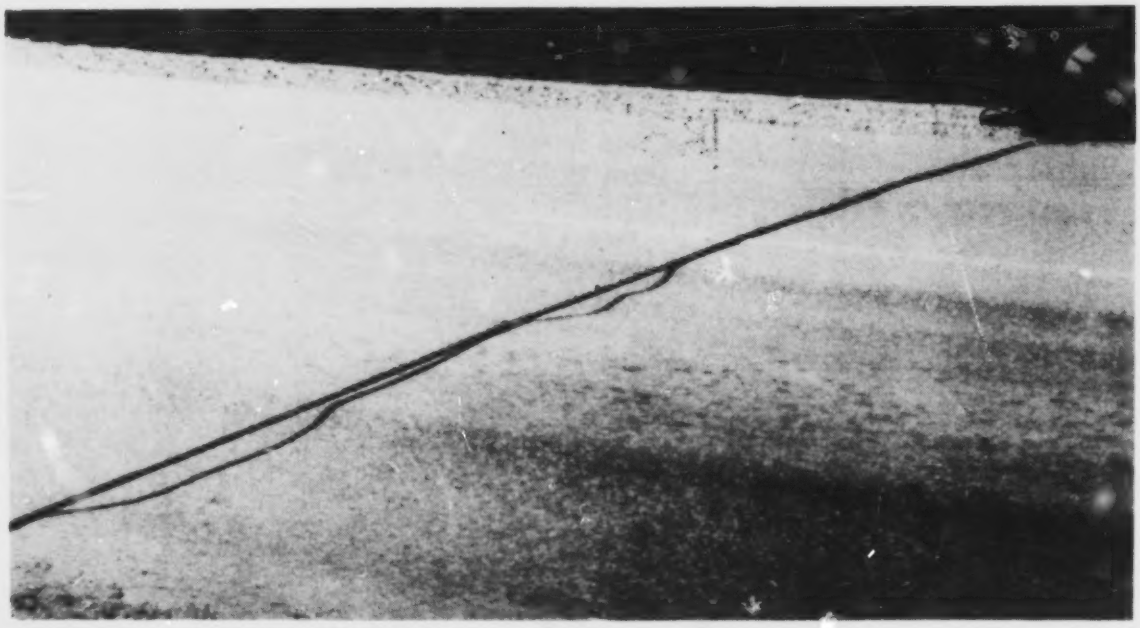
1. Poor construction technique and poor quality control.
2. Poor materials and/or material design.
3. Traffic action.

Severity:

Class	Guidelines (Based on appearance and rut depth measured with a standard 1.2 m gauge width)
Slight	Less than 10 mm.
Moderate	Up to 20 mm.
Severe	Greater than 20 mm.

Density:

Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.



Severe Double Wheel Track Rutting

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• No Action			
	General	• No Action			
Moderate	Local	• No Action			
	General	• No Action, but notify District Office and monitor, especially if it is Double Rutting			
Severe	Local	• Hot-Mix Patch	1001 1002	1002	3
		• Cold Planing/Milling		1006	
		• Heater Planing/Scarifying/Leveling		1090 (H)	
	General	• Mulching for highways with AADT less than 2000		1014	3
		• Granular Lift and Surface Treatment for highways with AADT less than 2000		1017	3
		• Hot-Mix Patch and Single Course Hot-Mix Resurfacing for highways with AADT greater than 2000		****	6
		• Hot-Mix Patch only and notify District Office	1001 1002	1002	3
		• Notify District Office only			

**** *Non-routine maintenance task; contract only.*

5/ Distress and Maintenance Treatments Rigid Pavement

5.1/ Cracking

Cracking

Cracking

Description:

Cracks either follow a course approximately parallel to or at right angles to the centre line of the pavement. They can be quite straight or wander like a serpent across the traffic lanes or diagonal to the centre line of the pavement.

Possible Causes:

1. Lateral contraction, bending or curling.
2. Fill settlement downward and/or outward.
3. Thermal expansion or contraction.
4. Over-long joint spacing.
5. Insufficient bearing support.
6. Swelling or shrinkage of subsoil.
7. Poor aggregates in concrete mix.
8. Poor joint performance due to improper construction.
9. Pumping through an adjacent transverse joint due to traffic action.
10. Concrete shrinkage.
11. Improper construction procedure.
12. Excessive compressive stresses.
13. Frost action (freeze-thaw).

Severity:

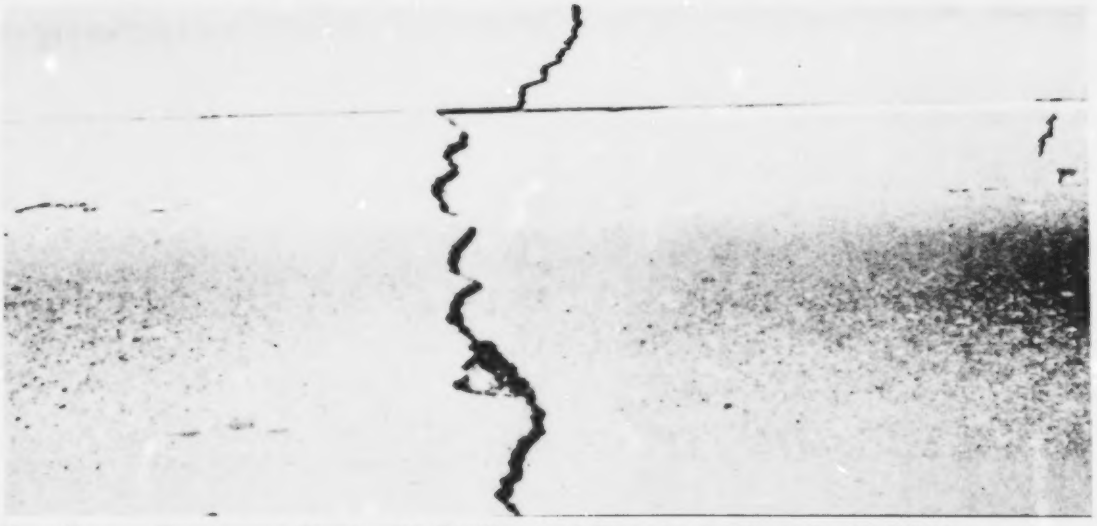
Class	Guidelines (Based on crack width and its condition)
Slight	3 mm to 13 mm.
Moderate	13 mm to 19 mm.
Severe	19 mm and up (with spalling and stepping developed).

Density:

Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.

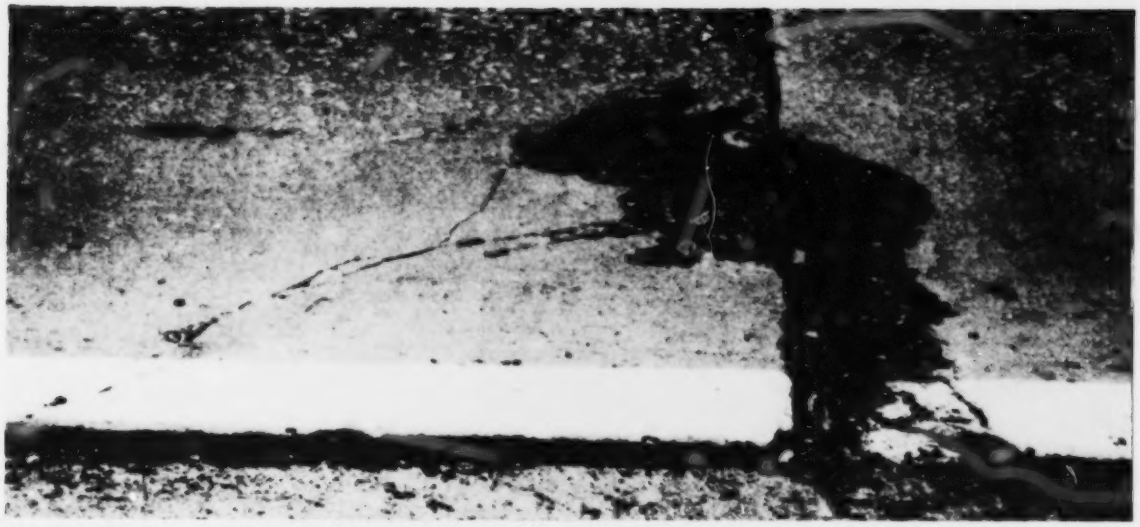
Longitudinal Cracking with Crack Spalling

Meandering Crack (Severe)



Very Severe Transverse Crack with Spalling and Stepping Infiltrated with Débris

'D' Cracks Developed into Multiple Cracking



Severe Corner Crack at Transverse Joint

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• No Action			
	General	• Rout and Seal all cracks greater than 6 mm		1005	
Moderate	Local	• Rout and Seal		1005	
	General	• Notify District Office	x		
Severe	Local	• Rout and Seal		1005	
	General	• Notify District Office	x		

5.2/ Joint Deficiencies

Joint Failure

Joint Sealant Loss

Joint Spalling

Joint Failure

Description:

Excessive breakdown of slab adjacent to joint so that patching is required to maintain or restore rideability.

Possible Causes:

1. High deflections of slab edges at joint under dynamic loads initiates spalls that progress into secondary spalls and then into joint failure. High deflections result from poor slab support and loss of material supporting the slab by pumping.
2. High compressive stresses resulting from creeping slabs; restrained joints and frozen dowels can result in pavement blow-up or shattering of the concrete near the joint.
3. Combination of 1 and 2.

Severity:

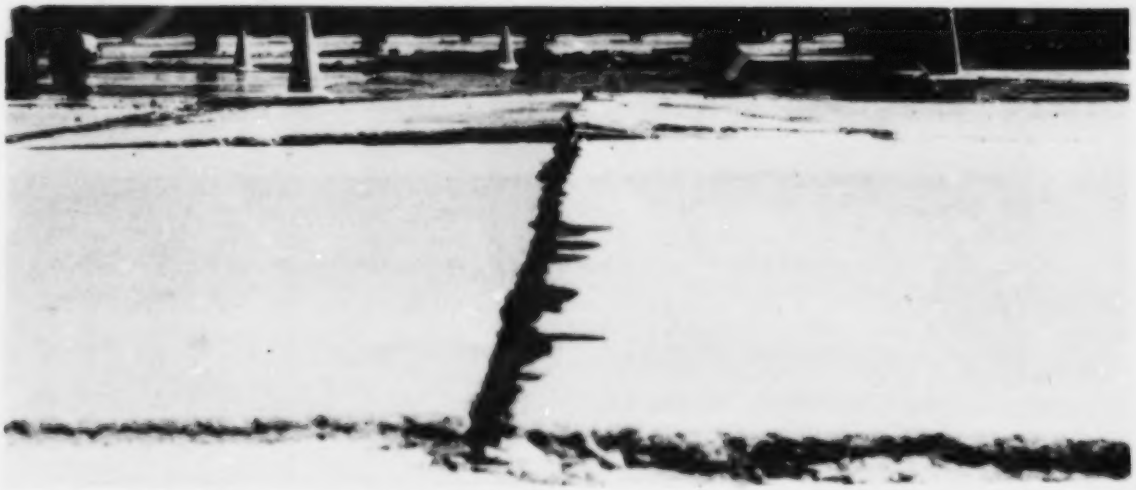
All joint failures are severe: they present a distressing visual effect, a very rough ride, and are inherently dangerous to the travelling public.

Density:

Local: Less than 30% of pavement surface affected; distress spotted over localized areas only.

General: More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.

Failure from Insufficient Bearing Support



Blow-up Failure from Compressive Stresses

Blow-up Failure (Shattering) from Compressive Stresses

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Only one Class and that is Severe	Local	• Excavate, granular and hot-mix patch • Excavate, granular and replace joint with cast-in-place**	1001 1002 1090*	 1090*	3 4
	General	• Hot-Mix Patch and notify District Office immediately	1001 1002	1002	2

* *No maintenance performance standard yet; usually contract.*

** *High early or normal concrete.*

Joint Deficiencies

Joint Sealant Loss

Description: Transverse or longitudinal joint sealant is being squeezed or pulled out of the joint.

Possible Causes:

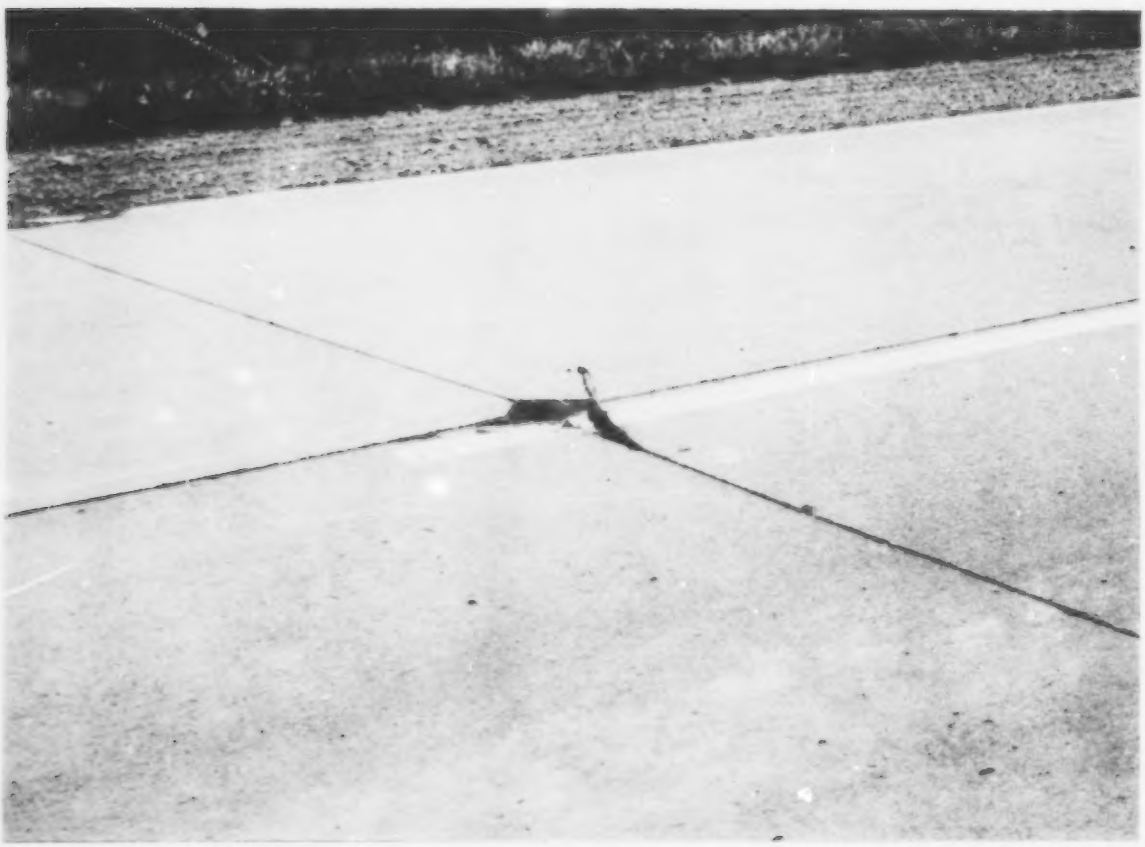
1. Traffic action.
2. Expulsion by compressive forces closing the joint too tightly.
3. Deterioration of sealant material.

Severity:

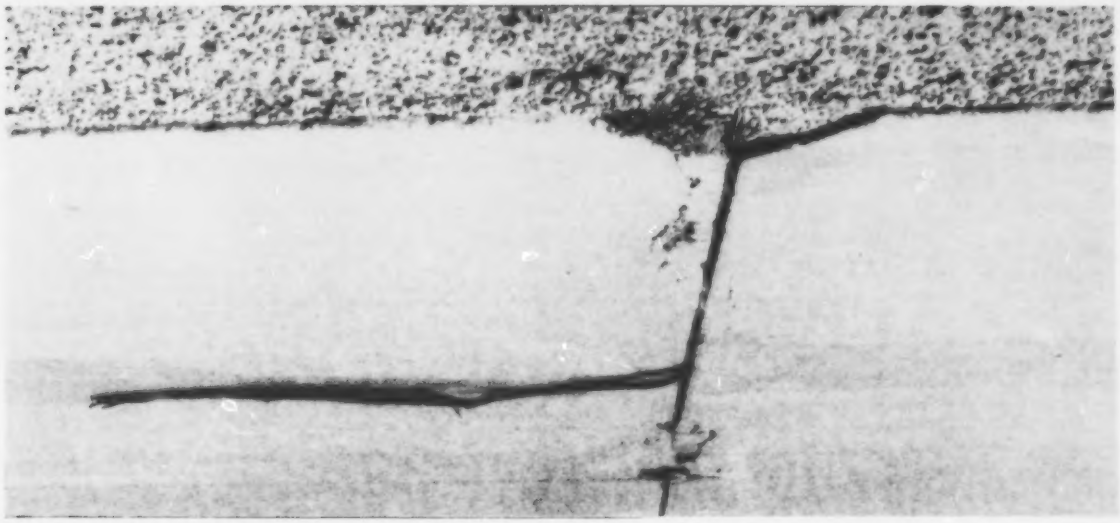
Class	Guidelines (Based on observation)
Slight	Sealant is broken and beginning to pull out (up to 300 mm).
Moderate	Sealant is broken and pulled out up to 50% of its length.
Severe	Sealant is broken and pulled out up to 80% of its length.

Density:

Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.



Slight Loss of Sealant



Severe Loss of Sealant

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• No Action			
	General	• Monitor and notify District Office	x		
Moderate	Local	• Clean out old sealant, resaw and clean, reseal with approved sealant	1005	1005	3
	General	• Same as above		1005	3
Severe	Local	• Same as above	1005	1005	
	General	• Notify District Office	x		

Joint Spalling

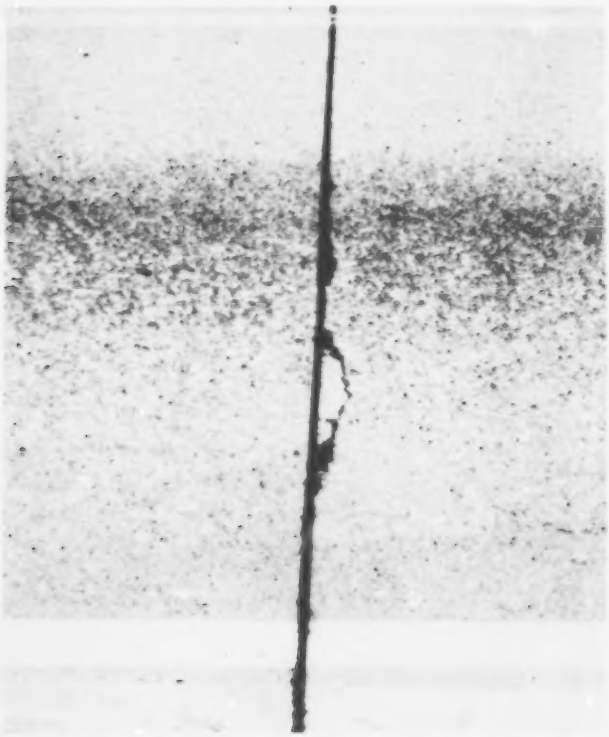
Description: Breaking or chipping of the pavement joints; usually results in fragments with feathered edges.

Possible Causes: Spalling of concrete edges is generally due to excessive local pressure caused by a combination of traffic, expansion, warping and curbing; spalling is progressive.

1. Expansive internal pressure due to corrosion of rebar or dowels.
2. Infiltration of debris; movment of slabs is thus prevented by excessive compressive stresses created by thermal expansion.
3. Seized dowel bars combined with thermal expansion.
4. Misalignment of dowel bars and base movement.

Severity:	Class	Guidelines (Based on width, length and depth of spalling)
	Slight	Small crack(s) with small pieces broken or missing.
	Moderate	Cracked with fractures, but no large pieces actually missing; some small pieces missing.
	Severe	Large pieces actually missing at or near wheel paths.

Density:		
	Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
	General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.



Slight Joint Spalling

Severe Joint Spalling

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• Notify District Office immediately			
	General	• Notify District Office immediately			
Moderate	Local	• Clean and Hot-Mix Patch if required	1001 1002		2
	General	• Clean and Hot-Mix Patch where required. Also notify District Office immediately for further consideration • Cutting of full depth stress relief joints	1001 1002	1002 1090 (V)	2
Severe	Local	• Clean and Hot-Mix Patch	1001 1002		2
	General	• Clean and Hot-Mix Patch and notify District Office • Cutting of full depth stress relief joints	1001 1002	1002 1090 (V)	2

5.3/ Surface Defects

Bump

Potholes

Sagging/Settlement

Scaling/Ravelling

Slippery Surface

Stepping (Faulting)

Surface Defects

Bump

Description:

Sharp local upward displacement of the pavement surface (usually caused by climatic and environmental factors). Generally occurs locally covering an area of about 3 m at most.

Possible Causes:

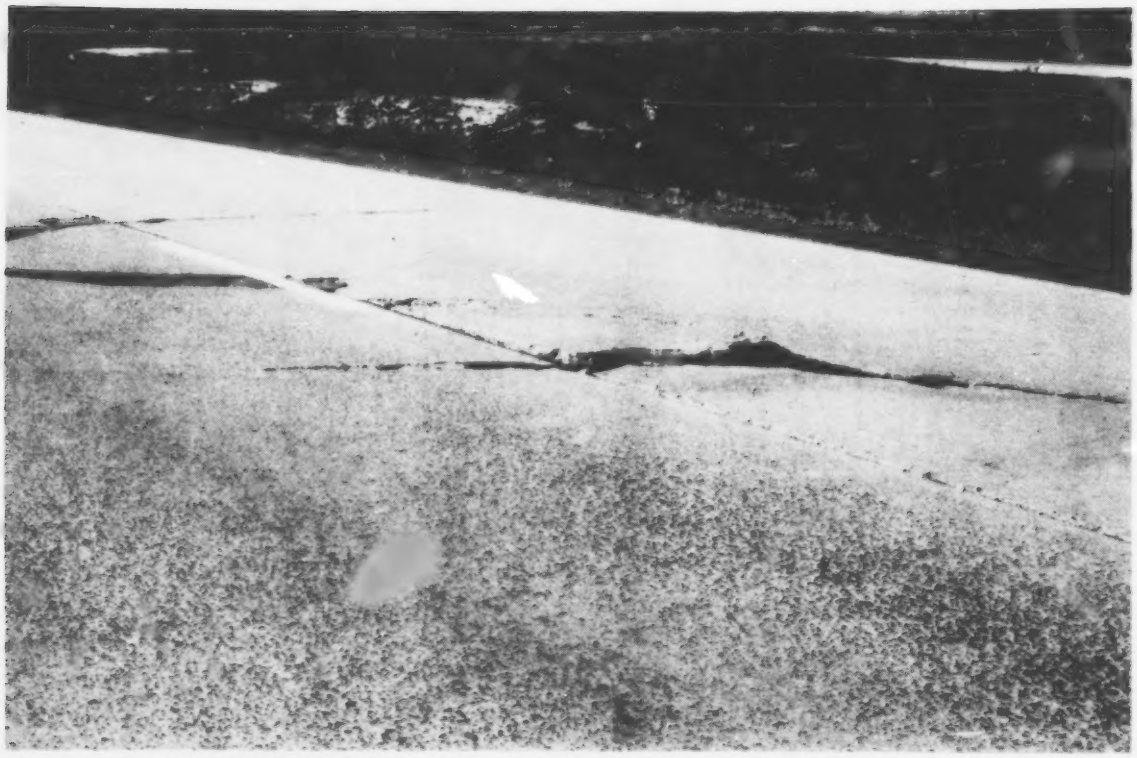
1. Frost heave.
2. Swelling of subgrade materials from moisture changes.

Severity:

Class	Guidelines (Based on observation of distress and effect on rideability)
Slight	Small bumpy effect on vehicle; vehicle still under control. Barely visible bump.
Moderate	Ramp-jumping effect on vehicle; vehicle still under control. Visible hump on pavement surface.
Severe	Ramp-jumping effect on vehicle; vehicle may lose control; large hump on pavement surface.

Density:

This type of distress occurs generally in localized areas. Therefore, density is classified as "Local" only.



Severe Bump Due to Frost Action

Frost-related Bump

Severe Bump from Joint Failure

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• Diamond Grinding • No Action, but notify District Office if frost-related	x	1006	
Moderate	Local	• Cold-Mix Patch • Hot-Mix Patch • Diamond Grinding	1001 1001 1002	 1002 1006	0.5 2
Severe	Local	• Cold-Mix Patch • Hot-Mix Patch • Excavate and back-fill with approved granular material and repair with concrete	1001 1002	 1002 1090 (C)	0.5 2

Potholes

Description: Bowl-shaped holes in pavement surface; can be unrelated to other surface defects, or a direct result of other defects such as ravelling, spalling, etc.

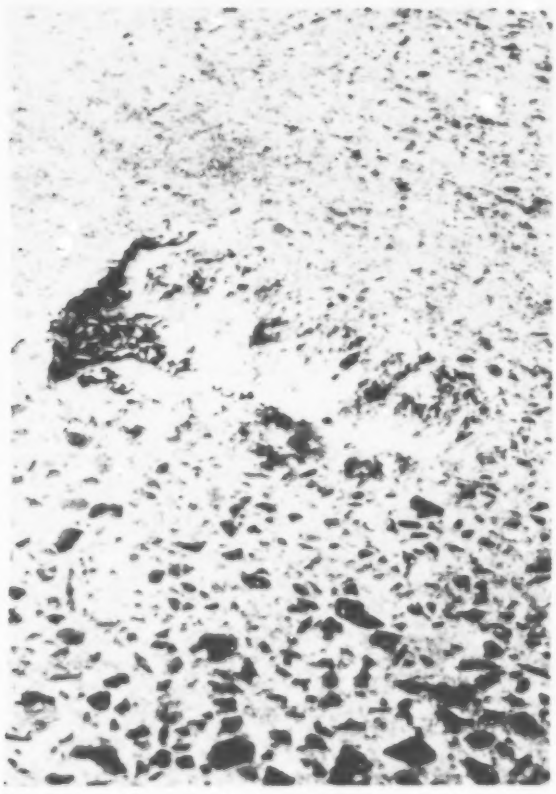
Possible Causes:

1. Poor construction technique and poor quality control of construction materials.
2. Frost action and traffic action.
3. Reinforcing steel placed too close to the surface.

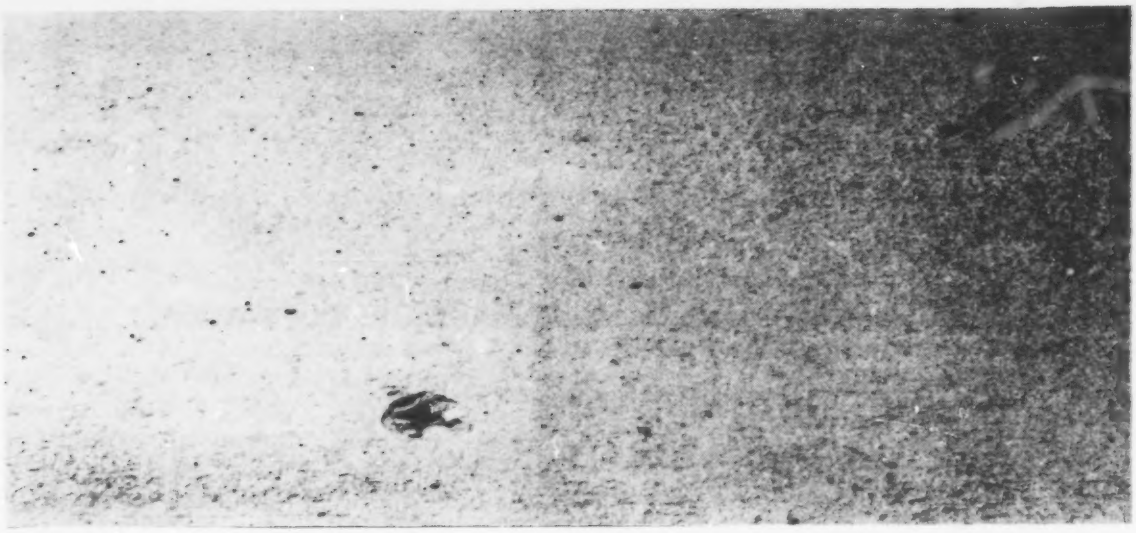
Severity:	Class	Guidelines (Based on observation)
	Slight	Small hole resembling pop-out of coarse aggregates with disintegration of surrounding material.
	Moderate	Size of hole much larger and deeper than pop-out of coarse aggregates.
	Severe	Pothole more than 150 mm wide and usually more than 100 mm deep.

Density:		
	Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
	General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.

Severe Pothole



Moderate Pothole



Slight Pothole

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local General	• No Action • Notify District Office			
Moderate	Local	• Cold-Mix Patch • Hot-Mix Patch	1001 1001 1002		0.5 2
	General	• Cold-Mix Patch • Hot-Mix Patch	1001 1001 1002		1 2
Severe	Local	• Cold-Mix Patch • Hot-Mix Patch	1001 1001 1002		1 2
	General	• Hot-Mix Patch with Single Course Resurfacing or thin bonded concrete overlay • Hot-Mix Patch and notify District Office	 1002	**** 1090 (C) 1002	 4 1.5

**** *Non-routine maintenance task; contract only.*

Sagging/Settlement

Description: Longitudinal deviation of the pavement surface from its original construction profile; the change in elevation is generally greater than 25 mm, with a wavelength of more than 3 m.

Possible Causes:

1. Poorly compacted base of subgrade and/or structure backfill.
2. Differential settlement of subgrade or base materials.
3. Lack of subgrade support.

Severity:	**Class**	**Guideline (Based on personal experience of the interaction between vehicle and pavement surface distortion)**
	Slight	Good control of vehicle still present for driver; a slight pitch and roll motion present.
	Moderate	Fair control of vehicle when driven over pavement; definite pitch and roll motion.
	Severe	Poor control of vehicle driven over pavement; driver always has to anticipate settlement ahead. Severe pitch and roll motion.

Density:	Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
	General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.

Settlement Sagging

Differential Settlement

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• No Action			
	General	• No Action, but notify District Office	x		
Moderate	Local	• No Action, but notify District Office for further consideration	x		
	General	• Hot-Mix Patch selected areas and notify District Office	1001/ 1002	1002	2
Severe	Local	• Subsealing or Mud Jacking		1090 (WS)*	
		• Hot-Mix Patch	1001 1002	1002	2
	General	• Hot-Mix Patch selected areas notify District Office	1001/ 1002	1002	2

* *Non-routine due to specialized nature and equipment involved. Expertise and assistance available from Pavement Design Section when this is warranted.*

Surface Defects

Scaling/Ravelling

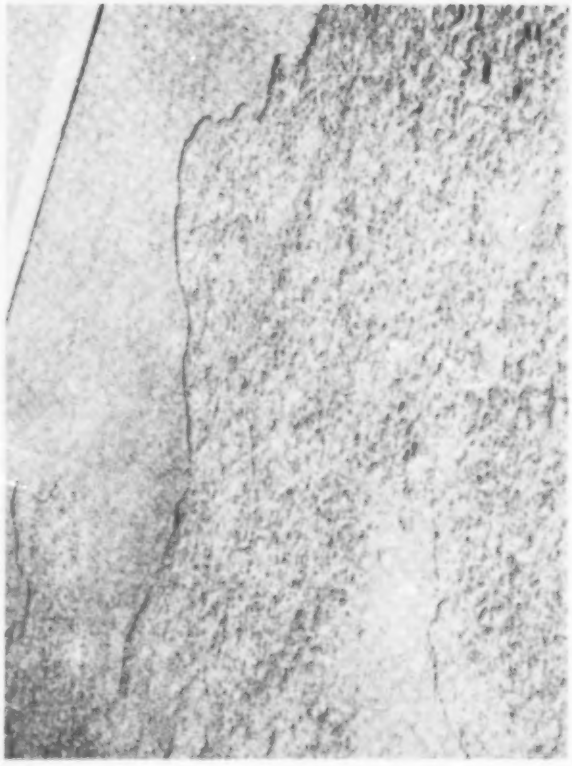
Description: Peeling away of the concrete pavement surface and loss of fine aggregates from matrix; may occur anywhere over the pavement surface.

Possible Causes:

1. Effect of freeze-thaw and/or de-icing chemicals on non air-entrained concrete.
2. Frost action.
3. Poor construction technique and poor quality control.

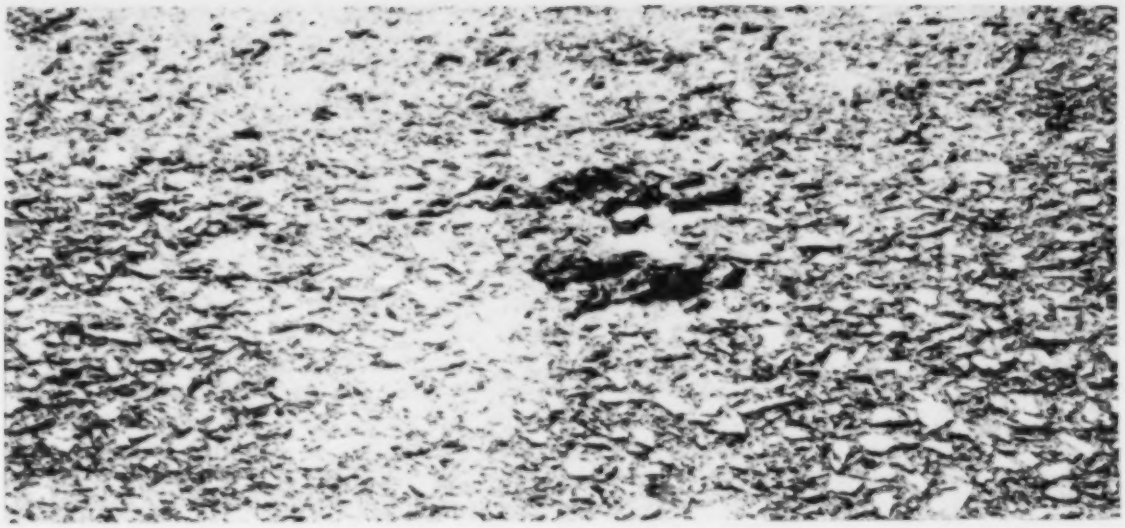
Severity:	**Class**	**Guidelines (Based on observation)**
	Slight	Very shallow flecking or peeling in small patches.
	Moderate	Shallow patches with open texture from peeling or flecking.
	Severe	Disintegration in shallow patches closely spaced; small shallow potholes.

Density:	Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
	General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.



Severe Scaling

Moderate Ravelling



Severe Ravelling

Treatments

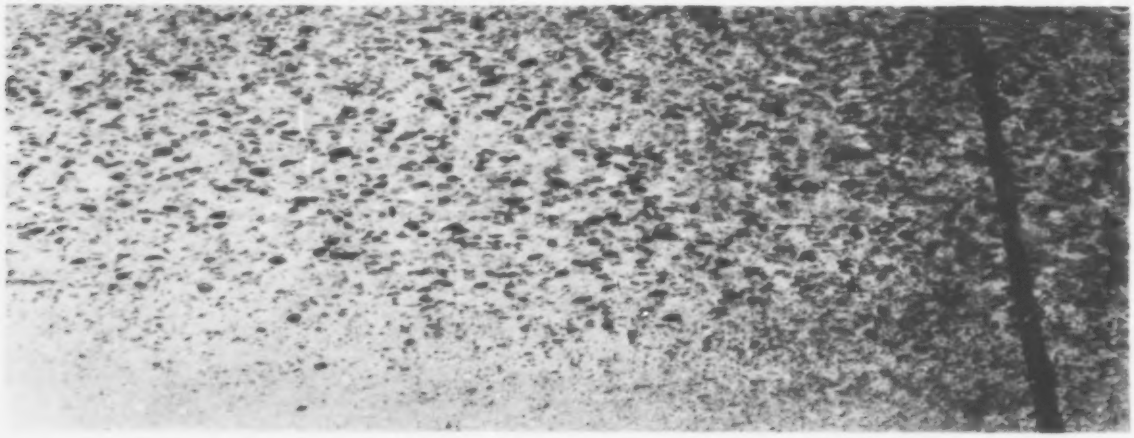
Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• No Action			
	General	• No Action			
Moderate	Local	• No Action			
	General	• No Action; Notify District Office	x		
Severe	Local	• Hot-Mix Patch • Thin Bonded Concrete Overlay	1001/ 1002	1090 (C)	4
	General	• Thin Bonded Concrete Overlay • Hot-Mix Patch and Notify District Office • Notify District Office	x	1090 (C) 1002	4

Slippery Surface

Description: Pavement surface appears polished and glossy.

Possible Causes: Traffic action on coarse aggregates, which are easily polished by traffic.

Severity: If slippery pavement surface is suspected, notify or consult District Office immediately. Maintain monitoring of suspected areas.



Polishing

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	Density		**Routine** patrol	**Non-Routine** crew / contract	
		• If any area of the pavement surface is suspected of being slippery, notify the District Office immediately of the problem situation, and maintain monitoring of the suspected areas. Possible treatments are: • Grooving • Diamond Grinding • Hot-Mix Patch		 1090(G)* 1006 1002	 5

* *No maintenance performance standard for grooving yet; usually contract work.*

Stepping (Faulting)

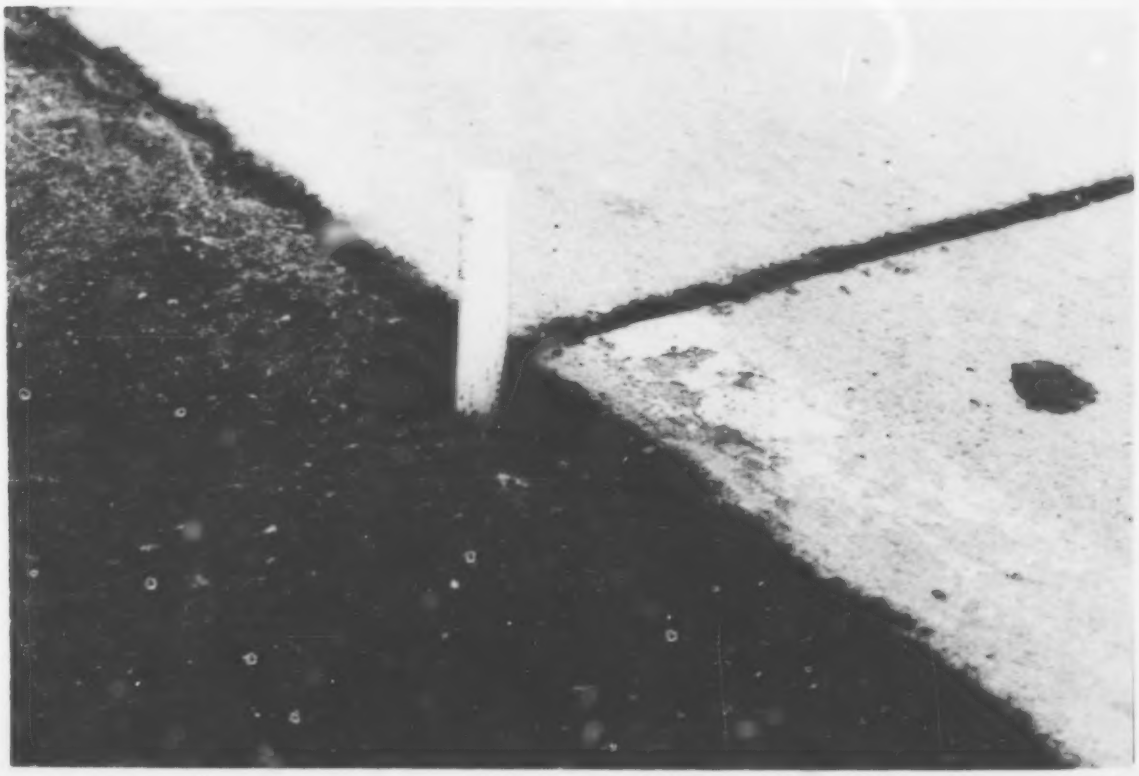
Description: Differential vertical displacement of abutting slabs at joints or cracks creating a "step" deformation in the pavement surface. Usually the "upstream" slab is higher than the "downstream" slab.

Possible Causes:

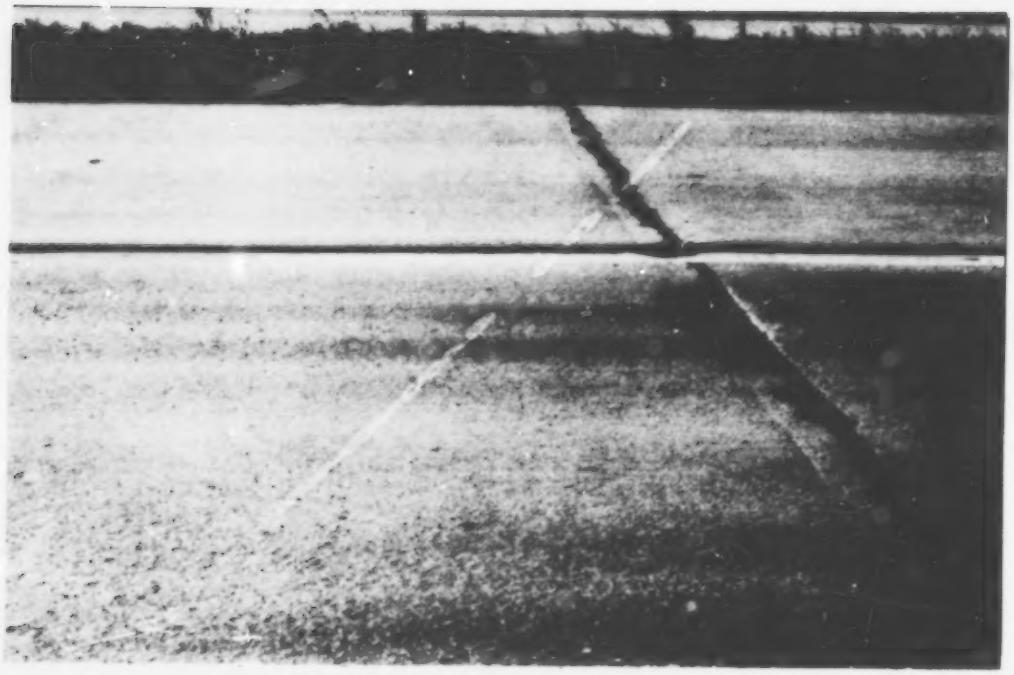
1. Pumping of slabs.
2. Lack of subgrade support.
3. Frost action.

Severity:	**Class**	**Guidelines (Based on height of stepping)**
	Slight	3 mm to 6 mm range.
	Moderate	6 mm to 13 mm range.
	Severe	Greater than 13 mm.

Density:		
	Local:	Less than 30% of pavement surface affected; distress spotted over localized areas only.
	General:	More than 30% of pavement surface affected; distress spotted evenly over entire length of pavement section.



Severe Transverse Joint Stepping



Moderate Longitudinal Joint Stepping

Severe Transverse Crack Stepping

Treatments

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	**Density**		**Routine** patrol	**Non-Routine** crew / contract	
Slight	Local	• No Action			
	General	• No Action, but notify District Office for consideration of subdrains	x		
Moderate	Local	• Reseal joint and crack (saw or rout if necessary) where stepping occurs	1005		
	General	• Reseal joint and crack (saw or rout if necessary) where stepping occurs plus installation of subdrains • Notify District Office for investigative action	x	1005	
Severe	Local	• Subseal voids to restore slab supports and reseal joint or crack where stepping occurs. • Remove step by diamond grinding.		1006* 1090(M/S)	
	General	• Hot-Mix Patch and installation of subdrains • Hot-Mix Patch selected areas and notify District Office for further consideration	1001 1002	1002 1002	3 4

* *Contract only*

6 / Distresses — Shoulder and Surface Drainage

Introduction

Distresses of the shoulder and of surface drainage greatly influence the performance and service life of a pavement.

Pavement shoulder distresses, particularly those of gravel shoulders, are important because they can be hazardous to the travelling public. Some of these distresses are also detrimental to the pavement's performance and service life, causing it to fail for example, by not providing adequate lateral support.

Surface drainage distresses can also become hazardous; for example, ponding of water on the pavement surface creates conditions ideal for hydro-planing — a very dangerous phenomenon. In addition, it is well known how detrimental improperly drained surface water can be to the pavement's performance and service life.

These distresses are pictorially presented in this chapter simply as a reminder of their importance. Details on maintenance procedures and quality standards are presented in the publication "Quality Standards".

6 / Surface Defects

- [ ] **Encroaching Growth**
- [ ] **Erosion / Washout**
- [ ] **Excessive Shoulder Slope Drop-off**
- [ ] **Pavement Edge Drop-off / Excessive Height**
- [ ] **Pavement / Shoulder Surface Drainage**
- [ ] **Potholes / Cracking (Stabilized or Paved Shoulders)**

Encroaching Growth

Description:

Vegetation growth overruns shoulder and reaches or approaches close to the pavement edge.

Possible Causes:

1. Shoulders are too narrow.
2. Improper maintenance practice.

Severe Encroaching Growth

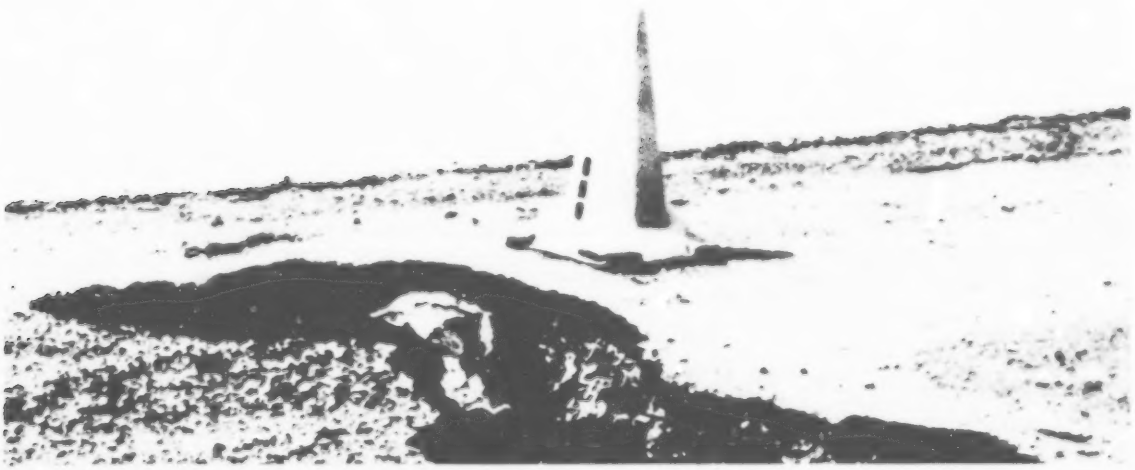
Erosion / Washout

Description: Massive loss of the shoulder's granular materials at or near the pavement edge.

Possible Causes:

1. Improper surface drainage design.
2. Improper maintenance practice.
3. Environmental calamities such as flooding, etc.

Improper Surface Drainage System



Severe Washout

Excessive Shoulder Slope Drop-off

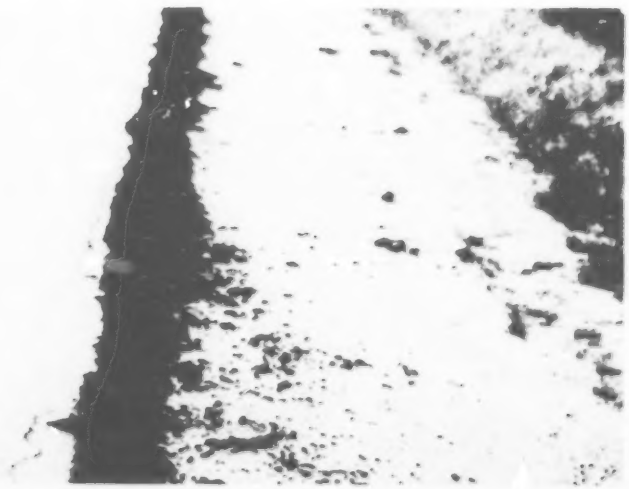
Description:

The shoulder has lost its proper crown. The excessive drop-off may occur along the entire shoulder or as an abrupt drop-off anywhere in the cross-section of the shoulder.

Possible Causes:

1. Traffic action.
2. Unstable materials.
3. Unstable base or subgrade.
4. Improper maintenance.

Moderate Shoulder Slope Drop-off



Severe Shoulder Slope Drop-off

Pavement Edge Drop-off / Excessive Height

Description:

Shoulder's granular materials are being pushed or removed from the pavement edge, creating a vertical drop-off; or granular materials are being windrowed into a ridge adjacent to the pavement that is higher than the pavement itself.

Possible Causes:

1. Traffic action.
2. Unstable granular materials used for the shoulder.
3. Improper maintenance.

Pavement Edge Drop-off

Excessive Height of Shoulder

Surface Defects

Pavement / Shoulder Surface Drainage

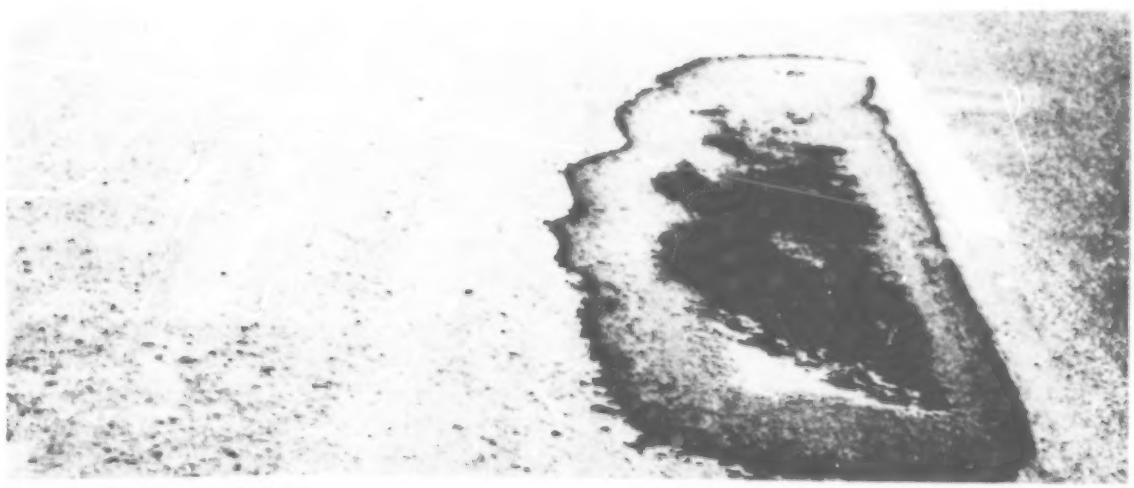
Description:

Free standing water trapped or unable to drain freely and properly from the pavement surface or shoulder surface.

Possible Causes:

1. Pavement surface rutting and distortions.
2. Curling of pavement edge.
3. Pavement edge drop-off or excessive shoulder height.
4. Excessive shoulder slope drop-off.
5. Excessive growth or vegetation at shoulder.
6. Improper surface drainage design.
7. Improper maintenance practice.

Cause: Curling of Pavement Edge



Cause: Pavement Dishing

Cause: Pavement Edge Drop-off

Cause: Improper Surface Drainage Design

Cause: Improper Maintenance Practice

Surface Defects

Potholes / Cracking (Stabilized or Paved Shoulders)

Description: These distresses occur in stabilized or paved shoulders in the same way as in pavements of similar type. Therefore, the same descriptions are applicable.

Possible Causes: After-effects of differential heaving, settlement.

Multiple Cracking on Paved Shoulder

Pothole on Paved Shoulder

7 / Performance Standards for Maintenance Treatments

Introduction

The Maintenance Performance Standard charts in this chapter will assist you in estimating the costs of various maintenance treatment alternatives. Recommended step-by-step maintenance procedures are also included.

Each chart describes the maintenance treatment required for particular road types and details the manpower, equipment and materials needed for the job, and how much can be accomplished in one day's work.

First, estimate the costs for each of those items; then you can calculate the unit cost for each treatment alternative.

$$\frac{\text{MANPOWER + EQUIPMENT + MATERIALS}}{\text{ACCOMPLISHMENT PER DAY}} = \text{UNIT COST}$$

Having completed that calculation, check back to the distress treatment table where the expected service life of the recommended treatment is listed. Now, calculate the equivalent annual cost.

$$\frac{\text{UNIT COST}}{\text{EXPECTED LIFE OF ALTERNATIVE (YRS)}} = \text{EQUIVALENT ANNUAL COST}$$

(For complete "how-to's" on calculating unit cost and equivalent annual cost, see Chapter 2.)

A comparison of the equivalent annual costs for each treatment alternative will indicate the one with the lowest cost; this is usually the most cost-effective and should be carried out unless other factors prevail (See Chapter 2).

List of Performance Standards

Flexible Pavement

M1001	Manual Patching	Placing and spreading hot- or cold-mix asphalt.
M1002	Machine Patching	Placing and spreading hot- or cold-mix asphalt.
M1003	Crack Filling	Filling crack with emulsion asphalt or cutback asphalt and blotting with sand or stone chips.
M1004	Spray Patching	Spraying of emulsion asphalt or cutback asphalt and spreading of covering sand or stone chips, with or without rolling.
M1005	Rout and Seal	Routing of cracks, cleanse and fill with hot pour rubberized asphalt or polymer sealant.
M1006	Cold Planing	Removal of pavement layers by cold planer or cold milling machine.
M1014	Mulch Pavement	Mixed in place mulching.
M1017	Surface Treatment	Spreading of emulsion asphalt and spreading of sand or stone chips and rolling of aggregate.
M1020	Subsurface Repair	Excavate, subdrain, backfill and surfacing.
M1090	Manual Patching with Recycled Hot-Mix Asphalt	Placing and spreading recycled hot-mix asphalt.
M1090(B)	Burning	Burning of pavement surface and resealing with chip seal or other patchings.
M1090(H)	Heater Planing	Heating, scarifying, and leveling of pavement surface in place.

Rigid Pavement

M1001(A)	Manual Patching	Placing and spreading hot- or cold-mix asphalt.
M1002	Machine Patching	Placing and spreading hot-mix asphalt.
M1005	Rout and Seal	Routing of cracks or joints, cleanse and fill with hot pour rubberized asphalt or polymer sealant.
M1006	Diamond Grinding	Grinding of pavement surface.
M1090(C)	Concrete Pavement Repairs with Concrete	Replacement of existing concrete pavement with concrete.
M1090(G)	Grooving	Grooving of pavement surface.
M1090(M/S)	Mud Jack/Subseal	Mud jacking of concrete slabs or subsealing of concrete slabs.
M1090(R)	Concrete Pavement Repairs with Recycled Hot-Mix Asphalt	Placing and spreading of recycled hot-mix asphalt.
M1090(V)	Cut Full Depth Stress Relief Joints	Installation of relief joints in concrete pavement joint blow-ups.

Ontario

Maintenance Performance Standard

M-1001 (Flexible Pavement)
Manual Patching–Placing and Spreading
Hot- or Cold-Mix Asphalt

Description

The manual placing and spreading of premixed asphaltic materials (hot- or cold-mix) to repair potholes, minor depressions, bumps, frost heaves and other pavement defects. Includes preparation of patching area and compaction.

Road Type			
Hot-Mix Multi-lane	Hot-Mix 2-3 Lane	Mulch 2-Lane	Prime and Surface Treated 2-Lane
Crew Size			
1-Driver 2-Shovellers/Rakers	1-Driver 2-Shovellers/Rakers	1-Driver 2-Shovellers/Rakers	1-Driver 2-Shovellers/Rakers
1 to 2-Drivers (For Traffic Control)	1 to 3-Flagmen (For Traffic Control)	1 to 3-Flagmen (For Traffic Control)	1 to 3-Flagmen (For Traffic Control)
Equipment			
1-Crew Carrier 1-Dump Truck 1-Portable Roller or Hand Tamp 1 or 2-Sign Trucks or Sign Trailers	1-Crew Carrier 1-Dump Truck 1-Portable Roller or Hand Tamp	1-Crew Carrier 1-Dump Truck 1-Portable Roller or Hand Tamp	1-Crew Carrier 1-Dump Truck 1-Portable Roller or Hand Tamp
Materials			
Hot- or Cold-Mix	Hot- or Cold-Mix	Cold-Mix	Cold-Mix
Accomplishment			
Tonnes	Tonnes	Tonnes	Tonnes
Manhours per Accomplishment			
5.7 - 10.0	4.0 - 8.0	5.0 - 5.7	4.5 - 5.3
Accomplishment Per Day			
7.0 - 4.0	10.0 - 4.0	8.0 - 7.0	9.0 - 7.5

Recommended Method

1. Set up safety devices and signs in accordance with "Traffic Control Manual for Highway Work Operations".

2. a) **Hot-Mix and Mulch Surface:** Remove all loose material, trim sides of patch area straight down. Sweep up debris, sweep out water.

   b) **Prime and Surface Treated:** Remove all loose material, sweep up debris, sweep out water.

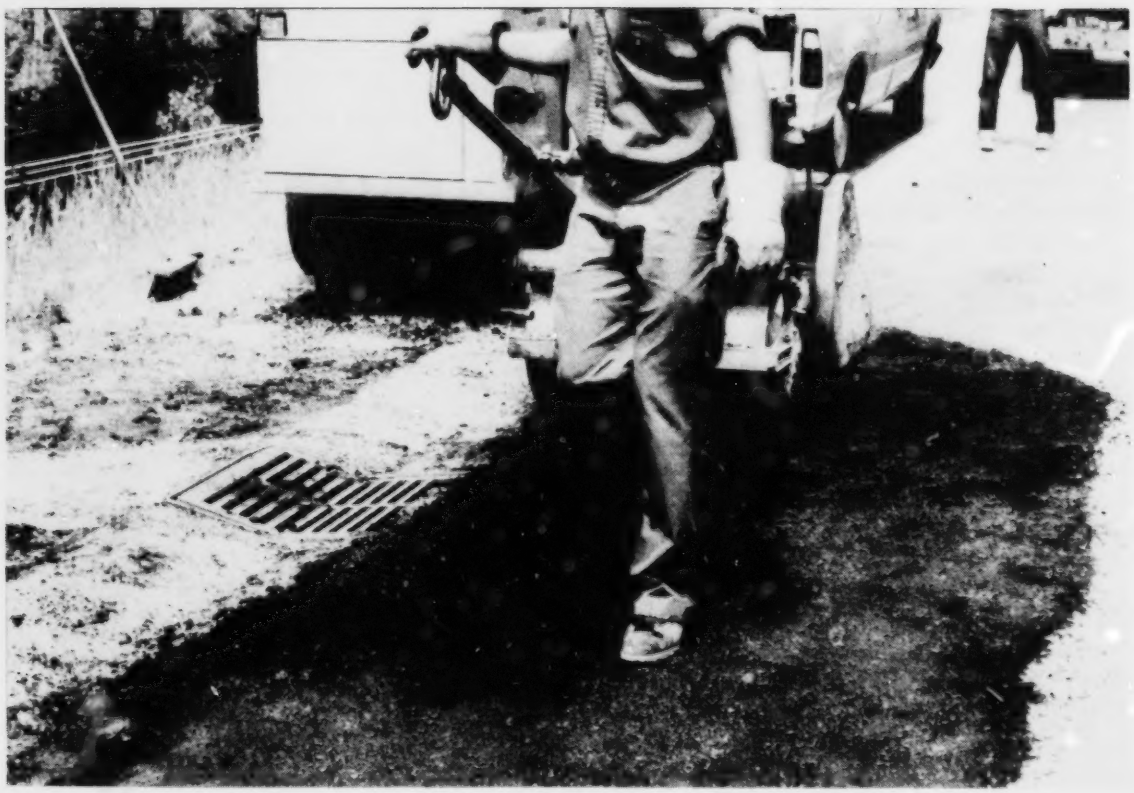
3. Apply a tack coat to provide a bond between the existing pavement and the patching material.

4. Shovel the mix into the patch area in lifts of not more than 80 mm against the sides and then toward the centre. Feather out the mix round the edges of the patch.

5. Place additional layers of mix 80 mm in thickness to bring the patch up to the level of the surrounding pavement.

6. Compact the mix with a portable roller, hand tamper or truck wheels.

Procedures for P'acing and Spreading Hot- or Cold-Mix Asphalt (Manual Patching)



Ontario

Maintenance Performance Standard

M-1001A* (Rigid Pavement)
Manual Patching—Placing and Spreading
Hot- or Cold-Mix Asphalt

Description

The manual placing and spreading of premixed asphaltic materials (hot- or cold-mix) to repair potholes, minor depressions, bumps, frost heaves and other pavement defects. Includes preparation of patching area and compaction.

**For use where existing concrete must be removed prior to placing patch.*

Road Type

Multi-lane
Concrete

Crew Size

1-Foreman
3-Drivers
1-Loader Operator
1-Saw/Roller Operator
2-Jackhammer Operators
2-Shovellers
1 to 2-Drivers
(Traffic Control)

Equipment

1-Crew Carrier
3-Dump Trucks
1-Loader
1-Concrete Saw
2-Jackhammers
1-Portable Roller
1-Cutting Torch
1-Plate Vibrator

1 or 2-Sign Trucks
Sign Trailers

Materials

Hot-Mix

Accomplishment

Tonnes

Manhours per Accomplishment

9.6 - 24

Accomplishment Per Day

10 - 4

Recommended Method

1. Set up safety devices and sign in accordance with "Traffic Control Manual for Highway Work Operations".
2. Remove broken sections in the patch area by sawing and jack hammering.
3. Clean out loose material from patch area by blowing and brushing.
4. Apply a tack coat to provide a bond between the existing pavement and the patching material.
5. Shovel the mix into the patch area in lifts of not more than 80 mm against the sides and then toward the centre. Feather out the mix around the edges of the patch.
6. Place additional layers of mix 80 mm in thickness to bring the patch up to the level of the surrounding pavement.
7. Compact the mix with a portable roller, hand tamper or truck wheels.

Procedures for Placing and Spreading Hot- or Cold-Mix Asphalt (Manual Patching)

Ontario

Maintenance Performance Standard

M-1002
Machine Patching
Placing and Spreading

Description

The machine placing and spreading of premixed asphaltic materials (hot- or cold-mix) to repair major surface defects such as depressions, bumps and other pavement defects. Includes preparation of patching area and compaction.

Road Type			
Hot-Mix Multi-lane	Hot-Mix 2-3 Lane	Mulch 2-Lane	Alternative Method For All Road Types
Crew Size			
1-Grader Operator 1-Roller Operator 2-Shovellers/Rakers	1-Grader Operator 1-Roller Operator 2-Shovellers/Rakers	1-Grader Operator 1-Roller Operator 2-Shovellers/Rakers	2-Screed Operators 1-Roller Operator 2-Shovellers/Rakers
1 to 5 Drivers (Asphalt Supply)	1 to 5 Drivers (Asphalt Supply)	1 to 5 Drivers (Asphalt Supply)	1 to 5 Drivers (Asphalt Supply)
1 to 2-Drivers (Traffic Control)	1 to 3-Flagmen (Traffic Control)	1 to 3-Flagmen (Traffic Control)	1 to 2-Drivers or 1 to 3-Flagmen (Traffic Control)
Equipment			
1-Crew Carrier 1-Grader 1-Roller	1-Crew Carrier 1-Grader 1-Roller	1-Crew Carrier 1-Grader 1-Roller	1-Crew Carrier 1-Tailgate Spreader 1-Roller
1 to 5-Dump Trucks	1 to 5-Dump Trucks	1 to 5-Dump Trucks	1 to 5-Dump Trucks
1 or 2-Sign Trucks or Sign Trailers			1 to 2-Sign Trucks or Sign Trailers
Materials			
Hot- or Cold-Mix	Hot- or Cold-Mix	Cold-Mix	Hot-Mix
Accomplishment			
Tonnes	Tonnes	Tonnes	Tonnes
Manhours Per Accomplishment			
0.7 - 2	0.7 - 2	0.7 - 2	
Accomplishment Per Day			
105 - 35	105 - 35	105 - 35	

Recommended Method

1. Set up safety devices and sign in accordance with "Traffic Control Manual for Highway Work Operations".
2. Remove any loose or broken sections of existing pavement extending into the good pavement about 300 mm. Clean up the patch area, removing all loose material and water.
3. Compact the subgrade, if necessary.
4. Apply a tack coat at each end of the patch and along the centre line joint when one lane is to be patched.
5. Place and spread the mix with a grader or a tailgate spreader.
6. Smooth and feather out the edges of the patch.
7. Be sure that enough mix material has been placed to obtain the proper grade and crossfall.
8. Compact the patch area, rolling progressively from the high side toward the low side, overlapping a few centimetres on each pass.

Note: Joints at the ends of the patch should be spray patched at a later date.

Procedures for Placing and Spreading Hot- or Cold-Mix Asphalt (Machine Patching)

Ontario

Maintenance Performance Standard

M-1003
Crack Filling

Description

The preparation* and filling of cracks with asphalt emulsions or liquid asphalts (cutbacks) followed by the spreading of aggregate (stone chips or sand). Include minor applications of these asphaltic and aggregate materials to small areas of distressed pavement, when performed during the major operation of crack filling.

** Preparation for this operation does not include routing.*

Road Type

Hot-Mix Multi-lane	Hot-Mix 2-lane

Crew Size

2-Drivers 1-Sweeper 1-Compressed Air Operator 1-Spray Bar Operator 2-Shovellers	2-Drivers 1-Sweeper 1-Comp. Air Operator 1-Spray Bar Operator 2-Shovellers
1 to 2-Drivers (Traffic Control)	1 to 3-Drivers (Traffic Control)

Equipment

1-Crew Carrier 1-Dump Truck 1-Maintenance Kettle 1-Air Compressor	1-Crew Carrier 1-Dump Truck 1-Maintenance Kettle 1-Air Compressor
1 or 2-Sign Trucks or Sign Trailers	

Materials

Asphalt Sand or Stone Chips	Asphalt Sand or Stone Chips

Accomplishment

Litres	Litres

Manhours Per Accomplishment

0.066 - 0.11	0.06 - 0.12

Accomplishment Per Day

970 - 600	1100 - 550

Recommended Method

1. Set up safety devices and signs in accordance with "Traffic Control Manual for Highway Work Operations".
2. Designate the areas requiring repair.
3. Clean out cracks using a stiff bristled broom and/or compressed air.
4. Fill cracks with asphalt, apply inside the crack to avoid creating a bump.
5. Cover the surface of the filled crack with dry sand or stone chips.

Procedures for Crack Filling

Ontario

Maintenance Performance Standard

M-1004
Spray Patching (Chip Seal)

Description

The application of emulsified asphalt or liquid asphalt (cutbacks) to areas of distressed pavement and pavement-edge defects, followed by spreading of aggregate (stone chips or sand).

Road Type

Hot-Mix Concrete Multi-lane	Hot-Mix Mulch 2-Lane	Prime and Surface Treated

Crew Size

2 to 3-Drivers 1-Spray Bar Operator 2-Shovellers 1 to 3-Flagmen (Traffic Control)	2 to 3-Drivers 1-Spray Bar Operator 2-Shovellers 1 to 3-Flagmen (Traffic Control)

Equipment

1-Crew Carrier 1 to 2-Dump Truck 1-Maintenance Kettle 1-Loader 2-Roofing Chip Spreader 1-Manual Spray Bar (Chip Seal) 1-Roller Compactor (Chip Seal)	1-Crew Carrier 1 to 2-Dump Truck 1-Maintenance Kettle 1-Loader 2-Roofing Chip Spreader (Chip Seal) 1-Manual Spray Bar (Chip Seal) 1-Roller Compactor (Chip Seal)

Materials

Asphalt Emulsion RS1 Stone Chips or Sand	Asphalt Emulsion RS1 Stone Chips or Sand

Accomplishment

Litres	Litres

Manhours Per Accomplishment

0.04 - 0.07	0.04 - 0.07

Accomplishment Per Day

1400 - 800	1400 - 800

Recommended Method

1. Set up safety devices and signs in accordance with "Traffic Control Manual for Highway Work Operations".

2. Clean the patch area; remove all loose material and debris.

3. When spray patching on primed or surface-treated roads, the patch areas should be compacted before repairs are made.

4. Spray the emulsion on the outside edges of the patch first, then spray the main area.

5. Apply the aggregate, spreading it to obtain an even coverage.

6. Sweep off loose aggregate around the patch.

Note: Double patches should generally be applied in the same season. If a second lift must be applied, the first lift should be allowed to "set up" a minimum of 24 hours.

To avoid "pick-up", traffic should not normally be allowed to travel on the newly patched area immediately after the material has been applied.

If "flushing" is observed, add additional material.

Procedures for Spray Patching (Chip Seal)

Ontario

Maintenance Performance Standard

M-1005
Rout and Seal
Concrete and Asphalt

Description

The routing of joints and/or cracks in concrete and asphalt pavement and the filling of same with joint fillers or rubberized asphaltic sealing compounds.

Road Type

Multi-lane Hot-Mix Concrete	2-3 Lane Hot-Mix

Crew Size

1-Foreman	1-Foreman
2-Drivers	2-Drivers
2-Router Operators	2-Router Operators
2-Sealant/Joint Filler Installers	2-Sealant Installers
or	or
1-Wand Application Operator	1-Wand Application Operator
1-H.C.A. Operator	1-H.C.A. Operator
1 to 2 Drivers	1 to 3 Flagmen (for Traffic Control)

Equipment

1 -1/2 Ton	1 -1/2 Ton
1-Crew Carrier	1-Crew Carrier
1-Stake Truck W/Air Compressor/H.C.A.	1-Stake Truck W/Air Compressor/H.C.A.
1-Heat Lance	1-Heat Lance
2-Routers	
1-Compound Melting Kettle	1-Compound Melting kettle
1 or 2-Sign Trucks or Sign Trailers	1-Stake Truck W/Tailgate Hoist
1-Stake Truck W/Tailgate Hoist	

Materials

Joint Filler/Crack Sealants	Crack Sealants

Accomplishment

Metres of Cracks/Joints Sealed	Metres of Cracks Sealed

Manhours Per Accomplishment

0.03 - 0.07

Accomplishment Per Day

700 - 1600

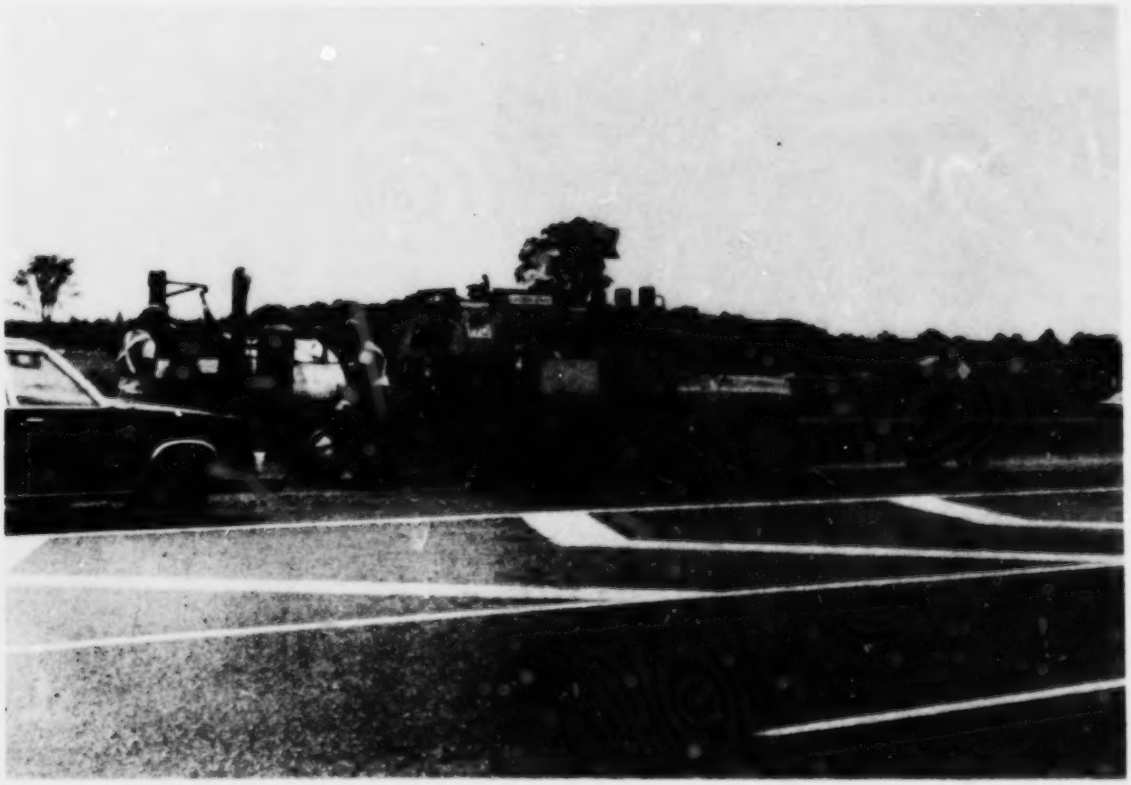
Recommended Method for Cracks

1. Set up safety devices and signs in accordance with "Traffic Control Manual for Highway Work Operations".
2. Rout cracks to standardized depth and width as specified.
3. Clean out and dry cracks with hot compressed air.
4. Seal cracks, applying the sealant uniformly as specified (overfill, underfill, or flush-fill).
5. If necessary apply a suitable bond breaker to prevent traffic pick-up of sealant materials.

Recommended Method for Joints

1. Set up safety devices and signs in accordance with "Traffic Control Manual for Highway Work Operations".
2. Rout out old seal (and filler if present) to a depth of 30 mm.
3. Clean the vertical faces of the joint and remove foreign materials from the pavement surface at least 30 mm on each side of the joint.
4. Blow out joints with compressed air at a pressure of at least 620 kpa with 71 dm^3/S of air at the nozzle.
5. Insert sponge rubber, plastic, or tape to the bottom of the groove.
6. Seal in one pour. (The outer ends of transverse joints must be dammed to prevent sealing materials from running out on to the shoulder.)

Procedures for Rout and Seal (Work Train)



Ontario

Maintenance Performance Standard

M-1006
Cold Planing/Milling

Description

The major pavement surface rehabilitation consisting of removal of surface defects by planing, leveling and removing excess material.

Road Type

Hot-Mix	
Concrete	Multi-lane
Multi-lane	2-3 Lane

Crew Size

1 to 3-Drivers	1 to 3-Drivers
1-Planer Operator	1-Planer Operator
1-Broom Operator	1-Broom Operator
1-Loader Operator	1-Loader Operator
1 to 2 Drivers	1 to 2 Flagmen
(Traffic Control)	(Traffic Control)
	or
	1 to 2 Drivers

Equipment

1-Crew Carrier	1-Crew Carrier
1 to 3-Dump Trucks	1 to 3-Dump Trucks
1-Self Propelled Cold Planer	1-Self Propelled Cold Planer
1-Power Broom	1-Power Broom
1-Loader	1-Loader
1 or 2-Sign Trucks or Sign Trailers	1 or 2-Sign Trucks or Sign Trailers

Materials

Accomplishment

Square Metres	Square Metres

Manhours Per Accomplishment

0.01	0.01

Accomplishment Per Day

7500	7500

Recommended Method

1. Set up safety devices and signs in accordance with "Traffic Control Manual for Highway Work Operations".
2. Premark the areas requiring repairs.
3. Plane the area(s) to a smooth surface, removing the distortion.
4. Clean up and haul away the material removed.

Note: If required, cover the planed surface with a surface treatment.

Procedure for Cold Planing

Ontario

Maintenance Performance Standard

M-1014
Mulch Pavement—Mixed in Place

Description

The mixing and placing of mulch pavement at the road site. Includes hauling aggregate to site, formation of aggregate windrow, road mixing with grader or other specialized equipment, spreading and compacting mixture.

Road Type

Primed Gravel
Mulch Surface

Crew Size

(Operation Steps 1, 2, 3)

1/ Spreading and Windrowing	*2/ Blade Mixing (or)*	*2/Blade and Travel Mixing*	*3/ Laying and Rolling the Mix*
1-Foreman	1-Foreman	1-Foreman	1-Foreman
2-Grader Operators	2-Grader Operators	3-Grader Operators	3-Grader Operators
1-Loader Operator	2 to 3-Flagmen	2-Pulvi-Mixer Operators	1-Roller Operator
1-Checker	(Traffic Control)	2 to 3-Flagmen	2 to 3-Flagmen
2 to 3-Flagmen		(Traffic Control)	(Traffic Control)
(Traffic Control)			

Equipment

1-Crew Carrier	1-Crew Carrier	1-Crew Carrier	1-Crew Carrier
2-Graders	2-Graders	3-Graders	3-Graders
1-Loader	1-Asphalt	2-Pulvi-Mixers	1-Roller
Hired Trucks as	Distributor (Hired)	1-Asphalt	1-Dump Truck
Required		Distributor (Hired)	1-Trailer

Materials

Granular	M.I.P. MC 800	M.I.P. MC 800
Material	or MC 250	or MC 250

Accomplishment

Kilometres of each lane paved

Manhours Per Accomplishment

30

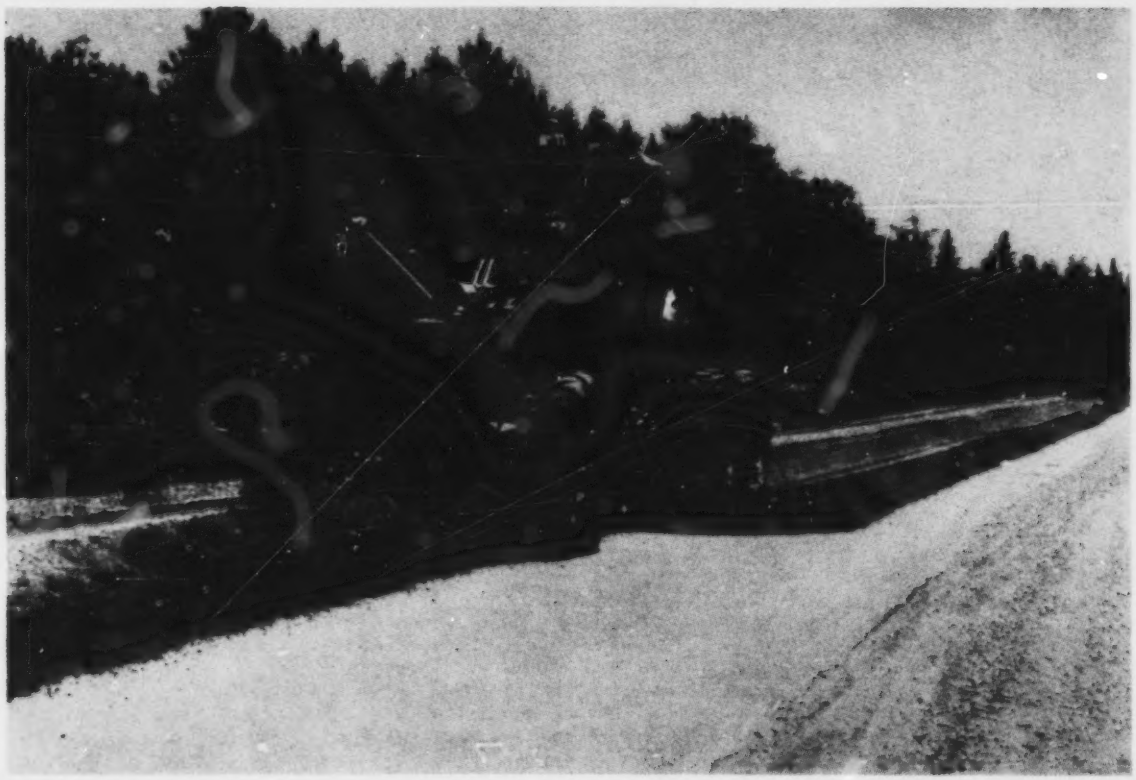
Accomplishment Per Day

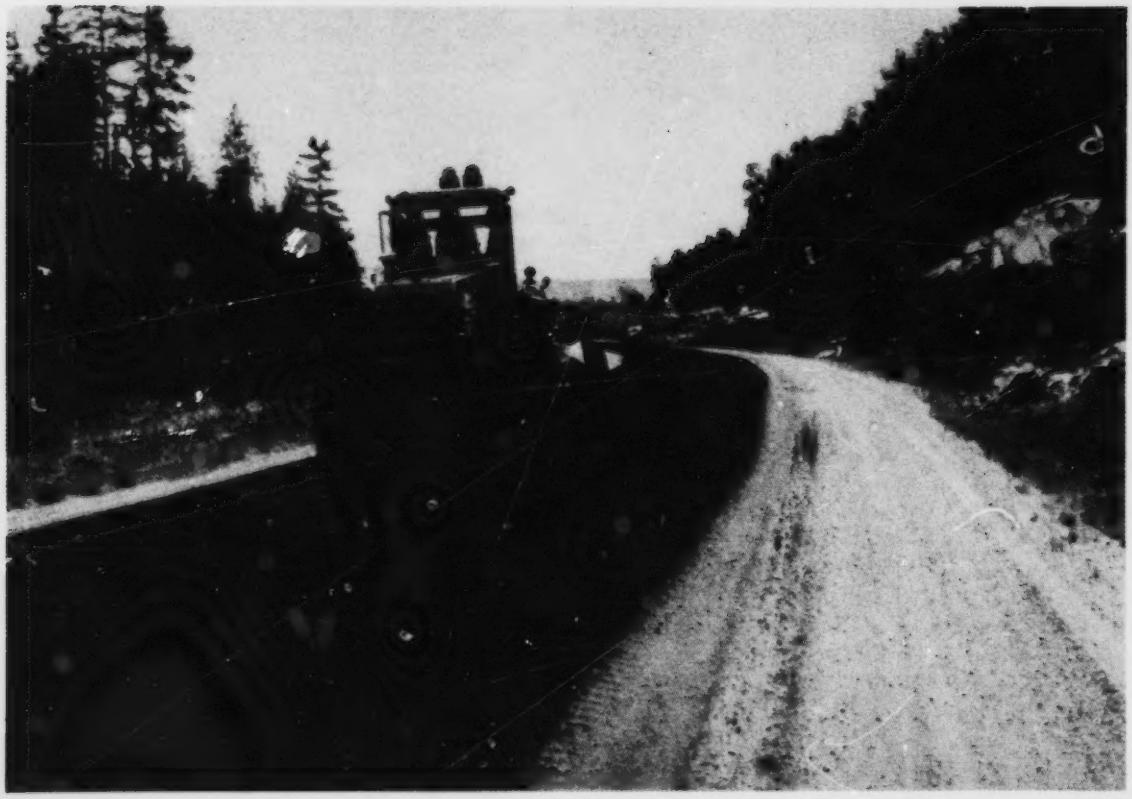
1.61

Recommended Method

1. Set up safety devices and signs in accordance with "Traffic Control Manual for Highway Work Operations".
2. Prepare existing road surface to acceptable grade and base conditions, including priming of gravel surface.
3. Dry the aggregate by repeated windrowing and spreading.
4. Apply the liquid asphalt (cutback) to the dried aggregate.
5. Mix the asphalt and aggregate by repeated windrowing and flattening until thoroughly mixed.
6. Spread the mix over the road surface.
7. Fine grade to required thickness, width and cross-fall.
8. Compact the new surface by
   a) a complete rolling after final grading,
   b) a second rolling the next day.
9. Complete the operation by grading up shoulder materials to edge of pavement.

Procedures for Mulch Pavement — Mixed in Place





Ontario

Maintenance Performance Standard

M-1017 (M-1017*)
Surface Treating (Sand Seal)

Description

The application on emulsified asphalt to continuous sections of road surface, followed by the spreading and rolling of aggregate.

(Sand Seal refers to a single surface treatment with fine aggregate.)

Road Type

Primed Gravel, Surface Treated,
Mulch Surface, Hot-Mix Surface

Crew Size

1-Foreman
2-Distributor Operators
2-Tail-End Operators
2-Aggregate Spreader Operators
1-Loader Operator
1-Wobble Wheel Roller Operator
1-Steel Wheel Roller Operator
1-Driver (Broom and Convoy)
1-Broom Helper/(Flagman)

2-Flagmen
(Traffic Control)

Equipment

1-Convoy and Crew Carrier
2-Distributors
1-Aggregate Spreader
1-Loader
1-Wobble Wheel
1-Steel Wheel Roller
1-Trailer Type Power Broom
1-Dump Truck
1-Trailer

DumpTrucks
(Hired)

Materials

RS1-K
HF150S
HF250S
Asphalt Emulsion
Aggregate

Accomplishment

Kilometres of each lane treated

Manhours Per Accomplishment

5.5

Accomplishment Per Day

22 lane-km

Recommended Method

1. Set up safety devices and signs in accordance with "Traffic Control Manual for Highway Work Operations". Traffic should be directed through the work site with warning signs, flagmen and a convoy truck.

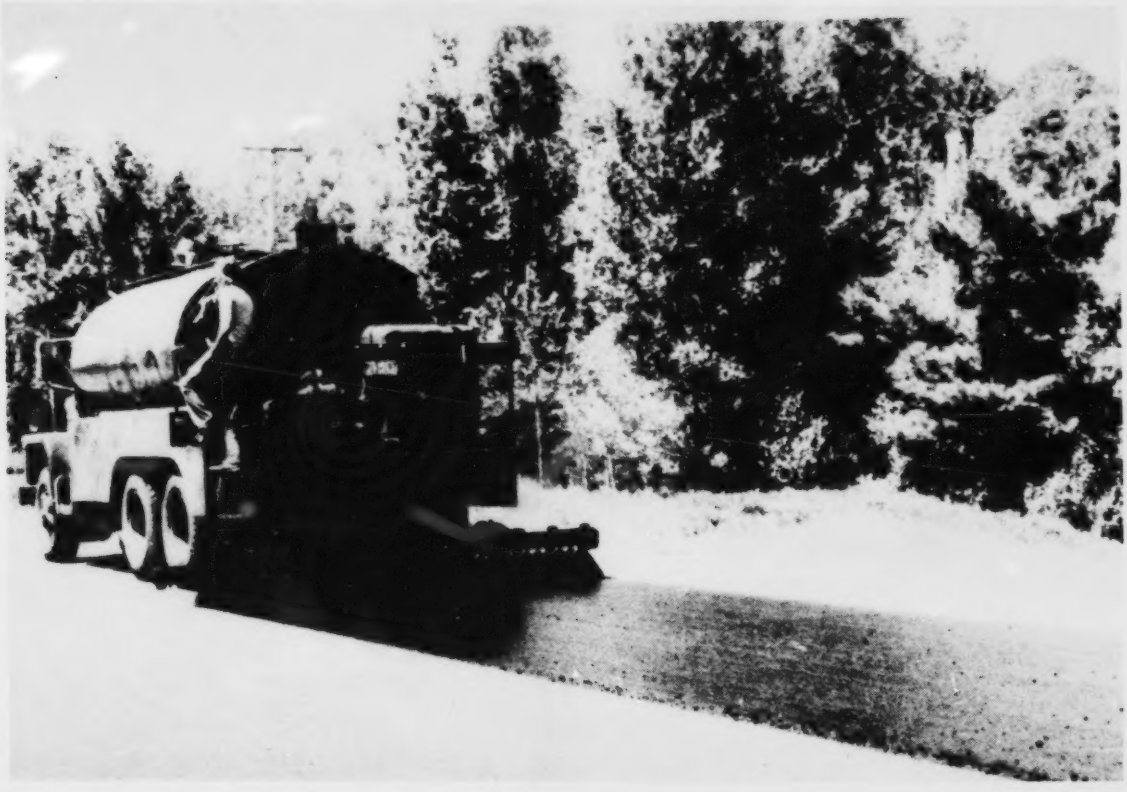
2. Sweep the existing surface prior to applying the asphalt.

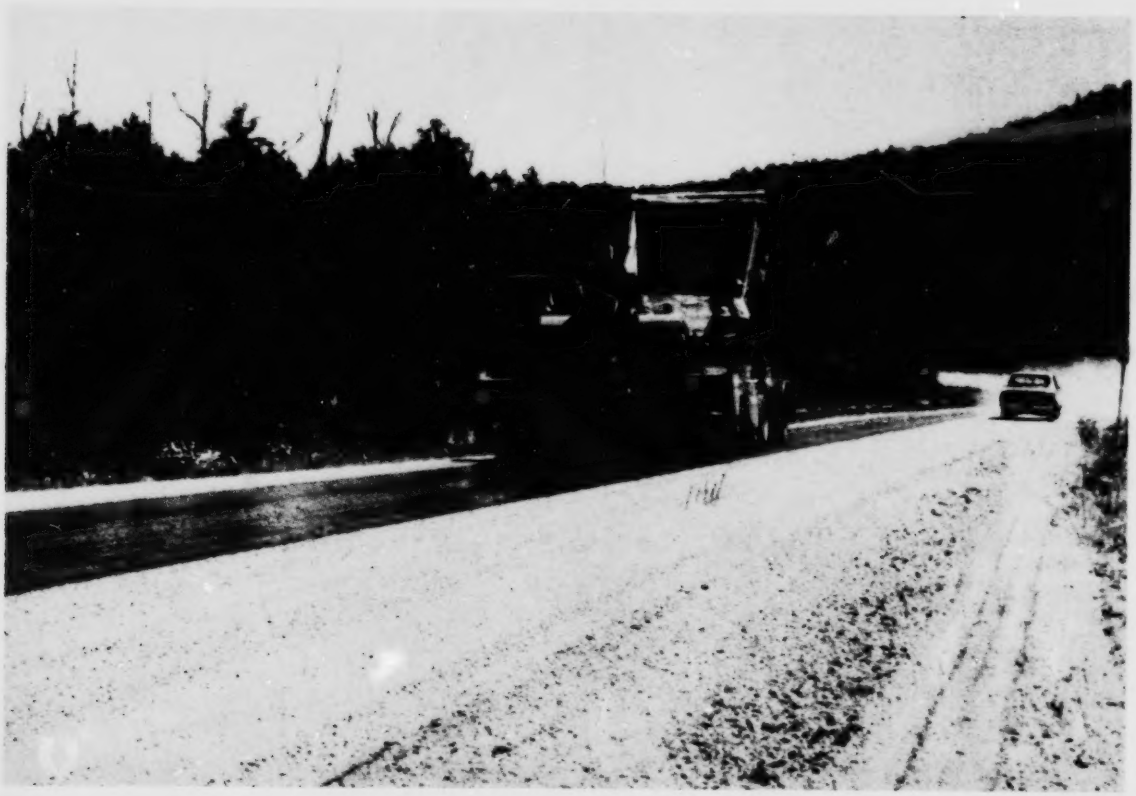
3. Spray the asphalt uniformly at the correct application rate and temperature.

4. Spread the aggregate uniformly over the sprayed surface. Remove excess aggregate.

5. Begin rolling immediately. Start with wobble wheel roller, followed by the steel wheel roller. Roll from the low side into the high side.

Procedures for Surface Treating (Sand Seal)





Ontario

Maintenance Performance Standard

M-1090 (Flexible Pavement)
Manual Patching—Placing and Spreading
Recycled Hot-Mix Asphalt

Description

The manual placing and spreading of recycled asphaltic materials to repair potholes, minor depressions, bumps frost heaves and other pavement defects. Includes preparation of patching area and compaction.

Road Type

Hot-Mix Multi-lane	Hot-Mix 2-3 Lane	Mulch 2-Lane

Crew Size

1-Driver 2-Shovellers/Rakers	1-Driver 2-Shovellers/Rakers	1-Driver 2-Shovellers/Rakers
1 to 2-Drivers (for Traffic Control)	1 to 3-Flagmen (for Traffic Control)	1 to 3-Flagmen (for Traffic Control)

Equipment

1-Crew Carrier 1-Dump Truck 1-Portable Roller 1-Recycler	1-Crew Carrier 1-Dump Truck 1-Portable Roller 1-Recycler	1-Crew Carrier 1-Dump Truck 1-Portable Roller 1-Recycler
1 or 2-Sign Trucks or Sign Trailers		

Materials

Propane, Reclaimed Asphalt	Propane, Reclaimed Asphalt	Propane, Reclaimed Asphalt

Accomplishment

Tonnes	Tonnes	Tonnes

Manhours Per Accomplishment

3 - 6	3 - 6	3 - 6

Accomplishment Per Day

13.3 - 6.7	13.3 - 6.7	13.3 - 6.7

Recommended Method

1. Set up safety devices and signs in accordance with "Traffic Control Manual for Highway Work Operations".

2. a) ***Hot-Mix and Mulch Surfaces:*** Remove all loose material, trim sides of patch area straight down. Sweep up debris, sweep out water.

   b) ***Prime and Surface-treated:*** Remove all loose material, sweep up debris, sweep out water.

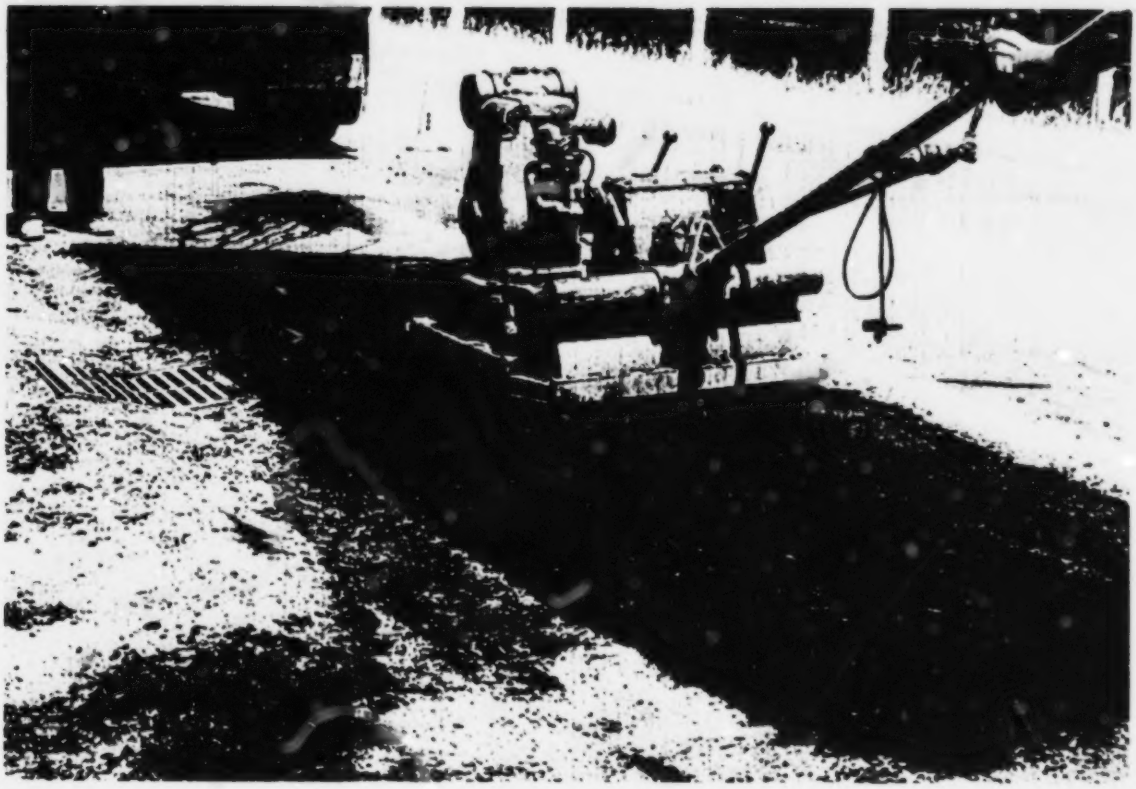
3. Apply a tack coat to provide a bond between the existing pavement and the patching material.

4. Shovel the mix into the patch area in lifts of not more than 80 mm against the sides and then toward the centre. Feather out the mix around the edges of the patch.

5. Place additional layers of mix 80 mm in thickness to bring the patch up to the level of the surrounding pavement.

6. Compact the mix with a portable roller, hand tamper or truck wheels.

Procedures for Placing and Spreading Recycled Hot-Mix Asphalt
(Manual Patching)



Ontario

Maintenance Performance Standard

M-1090 (S)
Burn (and Seal) Asphalt Pavement

Description

The elimination of excess surface asphalt, commonly called bleeding or flushing, by burning.

Road Type

Hot-Mix Multi-lane	Hot-Mix 2 Lane

Crew Size

1-Driver 1-Burner Operator 1-Labourer	1-Driver 1-Burner Operator 1-Labourer
1 to 2-Drivers (for Traffic Control)	1 to 3-Flagmen (for Traffic Control)

Equipment

1-Pickup Truck 1-Pavement Burner	1-Crew Carrier 1-Pavement Burner
1 or 2-Sign Trucks or Sign Trailers	

Materials

Accomplishment

Square Metres	Square Metres

Manhours Per Accomplishment

0.68	0.68

Accomplishment Per Day

60	60

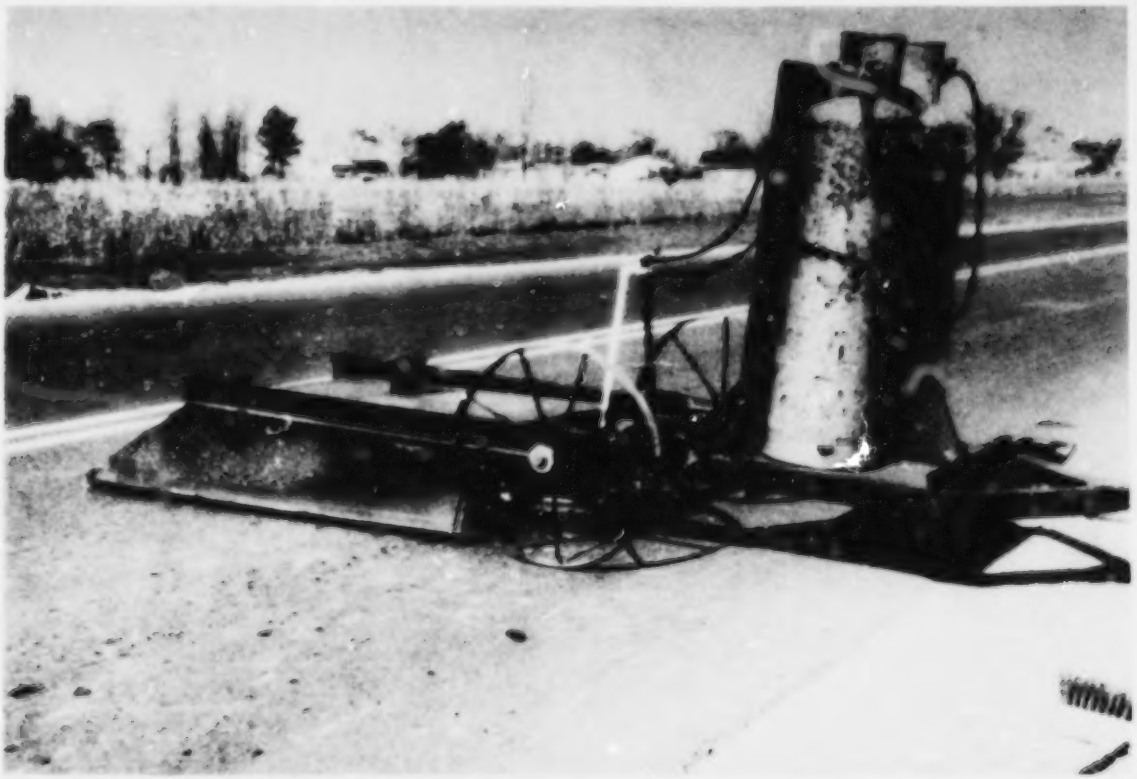
Recommended Method

1. Set up safety devices and signs in accordance with "Traffic Control Manual for Highway Work Operations".

2. Remove the asphalt film from the area; forward speed approximately 3 to 5 metres per minute.

   Note: Apply either a surface treatment or a seal coat after treatment. (See appropriate Performance Standard).

   The burner should travel into the wind to prevent flames from being forced under the truck. Crosswinds are detrimental because they force the flames to fluctuate, causing uneven burning and forcing the flames out from the under the hood. The burners must be shut off when trucks with flammable cargo are passing the operation. Ideal air temperatures for burning operations are 29° to 32°C. Operations at lower air temperatures cause excessive fuel usage. Fire prevention equipment should be provided when operating through areas of fire hazard.



Burner

Ontario

Maintenance Performance Standard

M-1090 (C)
Concrete Pavement Repair with Concrete

Description
Repairs to holes, blow-ups, spalled areas, scaled areas, etc., where the repair is done with concrete.

Road Type

Multi-lane	Multi-lane
Concrete	Concrete

Crew Size

Precast Slab		**Ready-Mix Concrete, Mobile Mix, Site Mix**	
1-Foreman	*1-Welder	1-Foreman	4-Labourers
1-Driver	(if required)	2-Drivers	
1-Float Operator	1 or 2-Drivers	1-Loader Operator	1 or 2-Drivers
1-Loader Operator	(for Traffic Control)	1-Roller Operator	(Traffic Control)
1-Roller Operator		2-Jackhammer Operators	
2-Jackhammer Opr.		1-Concrete Saw Operator	
1-Concrete Saw Drill Opr.			

Equipment

1-Crew Carrier	1-Air Drill	1-Crew Carrier	1 or 2-Sign Trucks/
1-Dump Truck	1-Arc Welder	2-Dump Trucks	Sign Trailer
1-Tractor and	(if required)	1-Loader	
Float Trailer	1 or 2-Sign	1-Air Compressor	
1-Loader	Trucks/Sign Trailers	2-Jackhammers	
1-Roller		1-Concrete Saw	
1-Air Compressor		1-Roller	
2-Jackhammers		1-Cutting Torch	
1-Concrete Saw		1-Concrete Vibrator	

Materials

Pre-Cast Slabs	Portland Cement Concrete

Accomplishment

Square Metres of pavement repaired	Square Metres of pavement repaired

Manhours Per Accomplishment

Accomplishment Per Day

** Usually contract work.*

Ontario

Maintenance Performance Standard

M-1090 (H)
Heater Planing, Scarifying, Leveling

Description

The major pavement surface rehabilitation consisting of removal of surface defects by heating, scarifying and leveling. Also includes removing excess material if necessary.

Road Type

Hot-Mix Multi-lane	Hot-Mix 2-Lane

Crew Size

1-Driver 1-Planer Operator 1-Float Operator 2-Sweepers/Shovellers 1 to 2-Drivers (Traffic Control)	1-Driver 1-PlanerOperator 2-Sweepers/Shovellers 1 to 3-Flagmen (Traffic Control)

Equipment

1-Crew Carrier 1-Dump Truck 1-Heater Planer 1-Steel Wheel Roller 1-Loader	1-Crew Carrier 1-Dump Truck 1-Heater Planer 1-Steel Wheel Roller 1-Loader

1 or 2-Sign Trucks
or Sign Trailers

Materials

Accomplishment

Square Metres	Square Metres

Manhours Per Accomplishment

0.03	0.03

Accomplishment Per Day

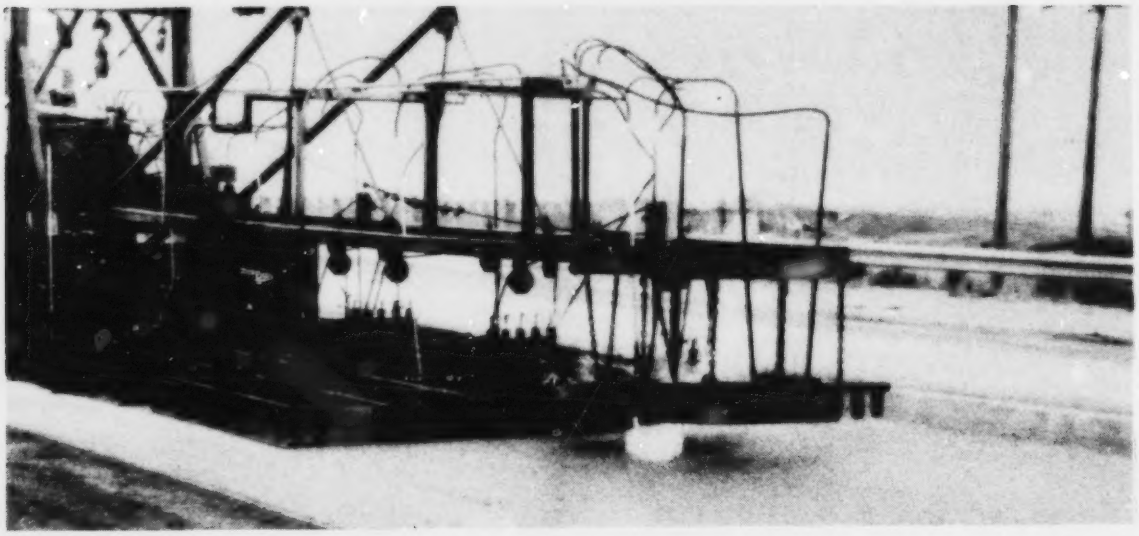
2500	2500

Recommended Method

1. Set up safety devices and signs in accordance with "Traffic Control Manual for Highway Work Operations".
2. Premark the areas requiring repairs.
3. Plane the area(s) to a smooth surface, removing the distortion.
4. Roll the planed surface.
5. Clean up and haul away the material removed.

   Note: If required, cover the planed surface with a surface treatment.

Procedures for Heater Planing



Ontario

Maintenance Performance Standard

M-1090 (M/S)
Subsealing/Mud Jacking—Concrete Pavement

Description

The subsealing of voids in the base beneath joints and cracks in Portland Cement concrete pavement. Raising sunken slabs to grade by pumping a concrete slurry underneath.

Road Type

Multi-lane
Concrete

Crew Size

1-Foreman
2-Drivers
1-Grout Pump Operator
1-Jackhammer Operator
1-Drill Operator
2-Labourers

1 to 2-Drivers
(Traffic Control)

Equipment

1-Crew Carrier
1-Stake Truck
1-Dump Truck
1-Grout Pump Mix.
1-Water Truck
1-Air Compressor
1-Drill
1-Jackhammer
1-Generator
1 or 2-Sign Trucks/Sign Trailers

Materials

Concrete Slurry Mix

Accomplishment

Square Metres

Manhours Per Accomplishment

0.53 1.07

Accomplishment Per Day

75 - 151

Recommended Method

1. Set up safety devices and signs in accordance with "Traffic Control Manual for Highway Work Operations".
2. Drill holes in slab on the indicated pattern.
3. Pump grout until lift is observed or material is observed flowing from hole to hole.
4. Plug holes.
5. Clean up.
6. Wait until initial set occurs in grout before opening to traffic.

Ontario

Maintenance Performance Standard

M-1090 (R) Rigid Pavement Concrete Pavement Repairs with Recycled Hot-Mix Asphalt

Description

Repairs to potholes, sagging/settlement, bumps, joint spalling, joint failures etc., where the repair is done with recycled hot-mix asphalt.

Road Type

Multi-lane
Concrete

Crew Size

1-Foreman
1-Concrete Saw Operator
1-Operator/Helper
2-Loader/Compressed Air Operator
1-Recycler Operator
1-Roller Operator/Helper

Equipment

1-1/2 Ton
*1-5 T Dump/W Water Tank
*1-Concrete Saw
*1-Trailer/Small Fixed Bed
2 Jackhammers
1-Loader
1-Tri-Axle Trailer
1-1/2 Ton
1-Roller
1-5 T Dump
1-Trailer/Small Tilt Bed
1-Recycler
1-5 T Sign Truck
1-Sign Trailer

Note: Generally these units will not be required on a full time basis.

Materials

Propane and Recycled Hot-Mix Asphalt

Accomplishment

Tonnes Used

Manhours Per Accomplishment

16 - 10.67

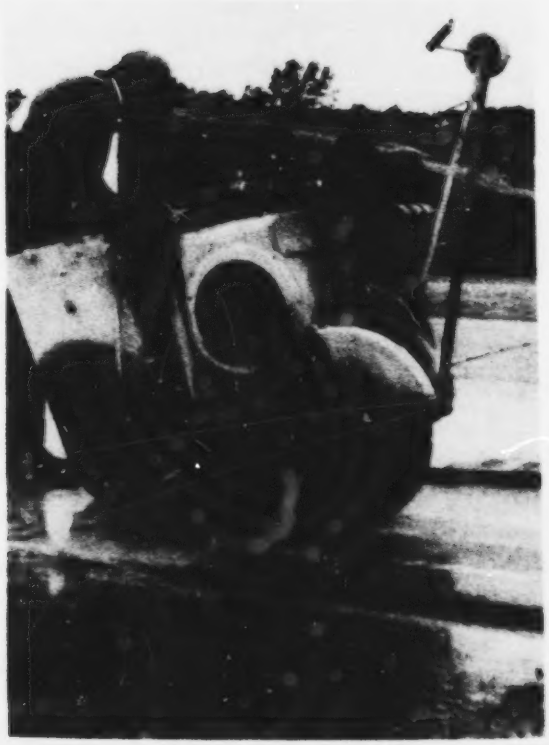
Accomplishment Per Day

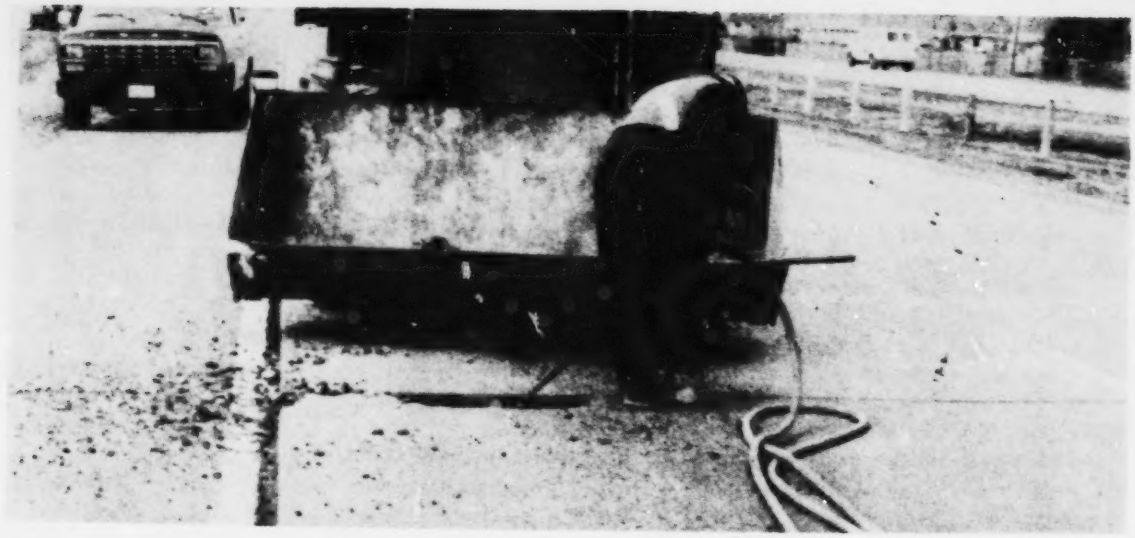
4 - 6

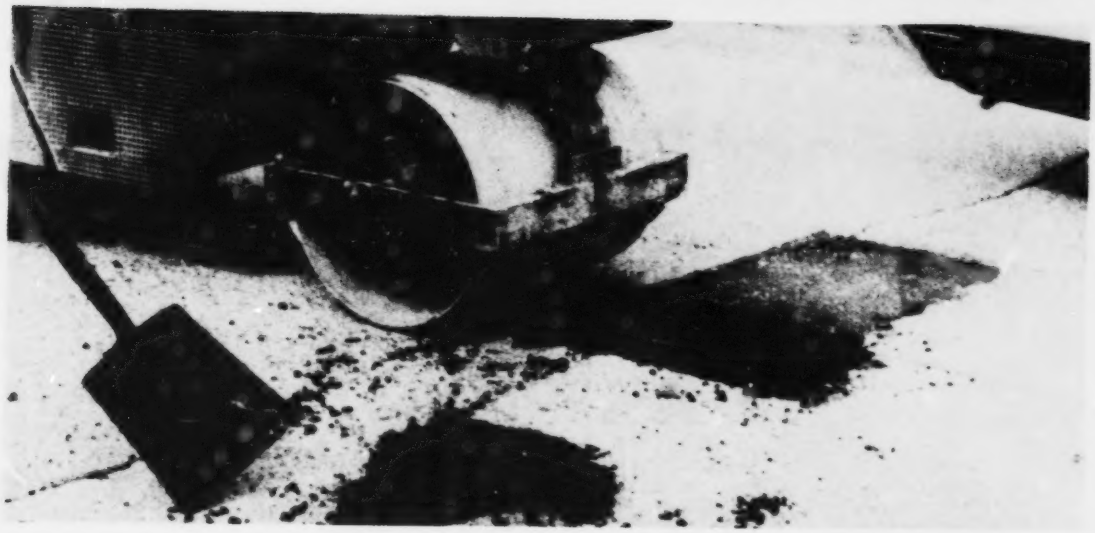
Recommended Method

1. Set up safety devices and signs in accordance with "Traffic Control Manual for Highway Work Operations".
2. Remove broken sections in the patch area by sawing and jack hammering.
3. Clean out loose material from patch area by blowing and brushing.
4. Apply a tack coat to provide a bond between the existing pavement and the patching material.
5. Shovel the mix into the patch area in lifts of not more than 80 mm against the sides and then towards the centre. Feather out the mix around the edges of the patch.
6. Place additional layers of mix 80 mm in thickness to bring the patch up to the level of the surrounding pavement.
7. Compact the mix with a portable roller, hand tamper or truck wheels.

Procedures for Concrete Pavement Repairs with (1) Hot or Cold Mix Asphalt and (2) Recycled Hot-Mix Asphalt.







Ontario

Maintenance Performance Standard

M-1090 (V)
Cut Full Depth Stress Relief Joints

Description

The installation of relief joints in concrete pavement joint blow-ups.

Road Type

Multi-lane
Concrete

Crew Size

1-Foreman
2-Drivers
1-Jackhammer Operator
1-Concrete Saw Operator
2-Labourers

1 or 2-Drivers
(Traffic Control)

Equipment

1-Crew Carrier
2-Dump Trucks
1-Air Compressor
2-Jackhammers
1-Concrete Saw
1-Maintenance Kettle
1 or 2-Sign Trucks/Sign Trailers

Materials

Joint Filler
Material Cold-Mix

Accomplishment

Lineal Metres

Manhours Per Accomplishment

2.32 - 4.8

Accomplishment Per Day

15 - 31

A/ Appendix
Pavement Maintenance Guidelines

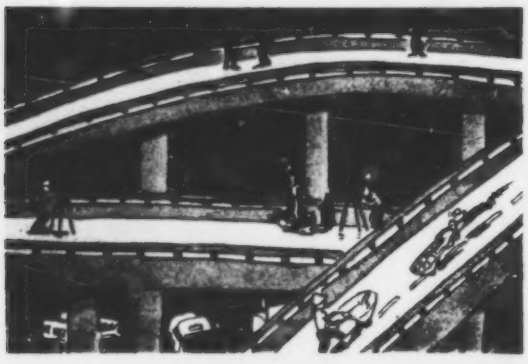
Audio/Visual Script — A Working Example

This appendix consists of a transcript and prints of a slide presentation entitled "Managing The Cost", which has been put together by MTO to help illustrate the guidelines outlined in this manual.

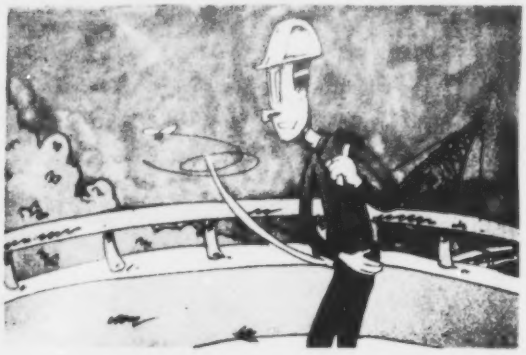
The complete audio-visual package is available on request.

Managing The Cost

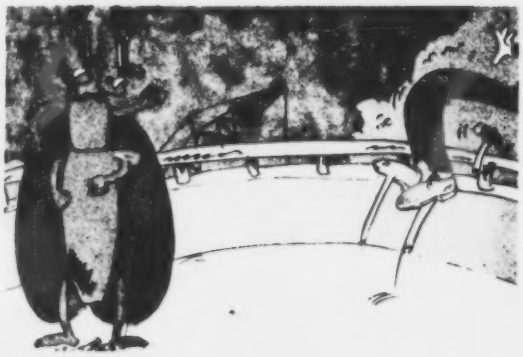
a guide to cost-effective pavement maintenance



Not so long ago, the emphasis was on expansion. Everything had to be bigger and better. The standards for our highway system were continually being upgraded. Lots of roadway construction was underway.

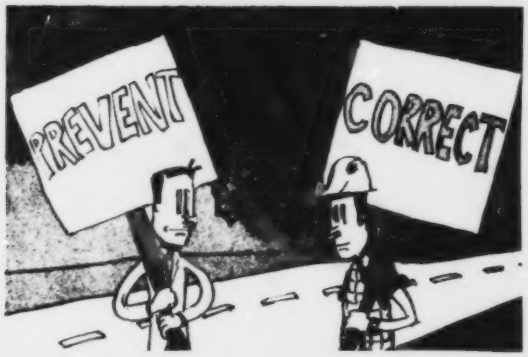


In that time of growth, inflation was only a minor annoyance.



But nowadays, the picture is different. The twin-headed monster of tight money and rising costs has brought about a significant change.

The emphasis now is on preserving what we have by maintaining and stretching the life of our highway pavements. This makes efficient pavement maintenance more important than ever.



To make our maintenance task more cost-effective, the Ministry has developed a system – a strategy for pavement maintenance. This strategy has two aspects: Preventive Maintenance and Corrective Maintenance.

In preventive maintenance, we try to head off trouble before it starts. The aim is to prevent premature deterioration and to slow the progress of existing defects. This way, any loss in service standard can be controlled. Preventive maintenance is usually a long-term situation. The regional geotechnical office plays the leading role but with your support.

In corrective maintenance, we've already got trouble. The job is to correct deficiencies before they become hazardous, and to repair distresses which could lower the pavement performance. Corrective maintenance is usually a short-to medium-term situation –the daily concern of the field maintenance staff.

It is corrective maintenance that we're going to talk about today. "Pavement Maintenance Guidelines", designed specifically for Maintenance Field Staff, has been put together by the Ministry. Every day you are faced with problems in the field, and every day you must decide how to deal properly with each problem of pavement distress.

the guide: the best decision is the most cost-effective

The major objective of the guide is to help you to make the best decision — the decision which is most cost-effective. In order to do this, the guide offers four areas of assistance:

(1) simple and easy way of identifying the problem

(1) A simple and easy way to identify and describe the problem.

(2) list of treatments and when to use them

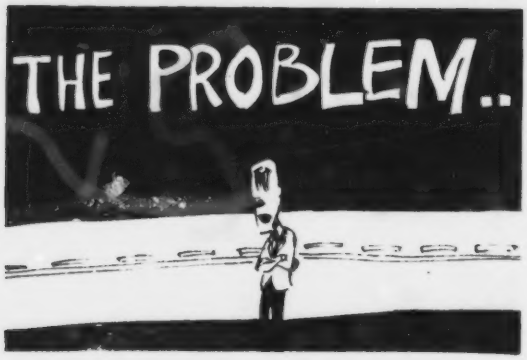
(2) A list of suitable treatments to correct the problem, and directions on when to use them.

(3) performance standard for manpower & equipment needs

(3) A performance standard which tells you the men, equipment and materials you'll need to do the job under different conditions, and how long it will take. Knowing this, you can determine the unit cost for each type of treatment.

(4) identify most cost-effective treatment

(4) A simple method of finding out which treatment is the most cost-effective.



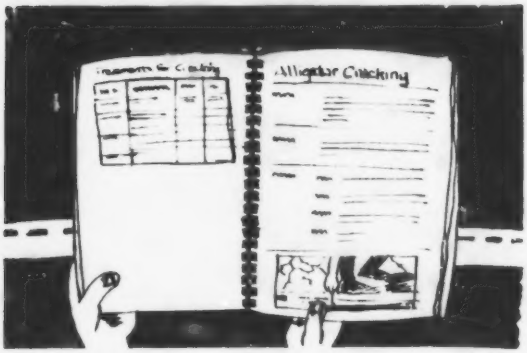
Right! Now that we've identified our four easy steps, let's take a closer look. First, there's The Problem. . .

Life without problems would be simple, wouldn't it? Simple, but dull. This lucky fella hanging from the tree doesn't need to worry about being bored. He has a problem to solve.

His first step must be to identify his problem.

Once he knows the nature of the problem, he can do something about it.

Now let's apply this to pavements and see how the guide works. Take this problem as an example.

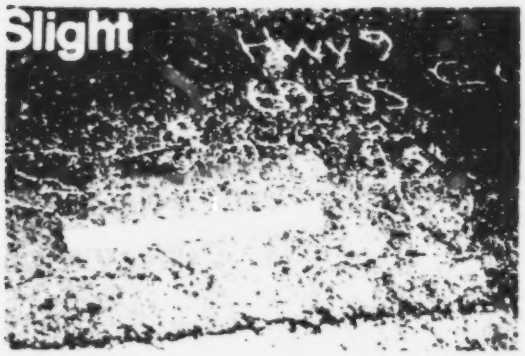


First, using the guide, identify the problem: give it a "name", check the photos, check the description of what it looks like, and read the brief summary of why it happens.

how bad is it?

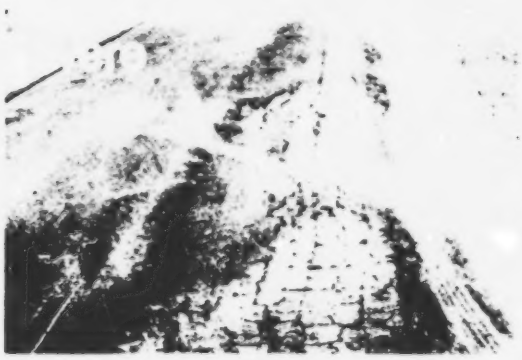
uniform description	guidelines
slight	alligator pattern established with corners of polygon blocks fracturing
moderate	alligator pattern established with spalling of polygon blocks
severe	polygon blocks begin to lift; may involve pot holes

Next, use the guide to answer "How bad is it?" In very simple terms is it slight? moderate? or severe? The guide gives you a verbal description of each stage and it gives you pictures.



This is "slight" alligator cracking.

This is "moderate" alligator cracking.



And this is "severe" alligator cracking.

how big is it ?	
local:	less than 30% of surface is affected; distress is spotted over localized areas only
general:	more than 30% of surface is affected; distress is spotted evenly over pavement section

Now that we know what, why, and how bad it is, we have to answer the question: "How big is it?" In other words, what is the degree of the problem? In our guide, problems only come in two sizes: local or general.

Now comes the tough part – we have to decide what to do about it. In the words of an old proverb: "We've got the tiger by the tail" – so what happens next? Well, all we do is consult the Guide.

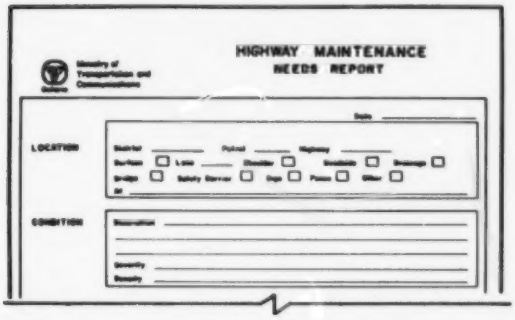
Treatments for Alligator Cracking

Evaluation		Recommended Maintenance Treatment Alternatives
Severity	Density	
Slight	Local	No Action
	General	No Action but monitor closely for future development
Moderate	Local	Spray Patch
		Cold Mix Patch
		Hot Mix Patch
		Hot Mix Patch for multi-lanes
	General	Same as above but notify District Office of situation and maintain close monitoring
Severe	Local	Cold Mix Patch
		Hot Mix Patch

The guide contains a list of the treatments available to us. From this list we shall choose one treatment which solves our problem and, at the same time, is the most cost-effective.

Treatments for Alligator Cracking

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Priority Classification	
Severity	Density		Routine patrol	All-in-patrol
Slight	Local	No Action		
	General	No Action but monitor closely for future development		
Moderate	Local	Spray Patch	1004	
		Cold Mix Patch	1001	
		Hot Mix Patch	1001 1002	1002
		Hot Mix Patch for multi-lanes		1002
	General	Same as above but notify District Office of situation and maintain close monitoring		
Severe	Local	Cold Mix Patch	1001	
		Hot Mix Patch	1001 1002	1002

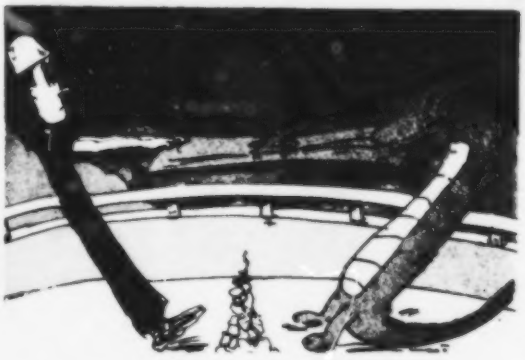


Then we must decide who is going to carry out the work – can your patrol do it or is it just too big a job that must be done by combined patrol forces or by contract? The simple question here is "can I do it, or is it beyond my resources?"

If you decide the job is too big for your patrol to handle, then you can submit the "Highway Maintenance Needs Report" to your district office.

After deciding WHO should do it, the question becomes HOW and to what standard. For each chosen treatment, the Guide tells you the manpower and equipment needed to do the job. It also tells how much work can be done each day given those men and equipment.

This is all based on past experience. We know the best crew size and the amount and type of equipment needed to lay a given amount of material in one day. This is our maintenance performance standard, and is available for every treatment. But we can't just do the job, we must do it cost-effectively. Now we're talking money!



"How much treatment can we get for a dollar? Is this the best a dollar can buy?" To answer these questions, let's do some simple calculations.

(1) manpower spent

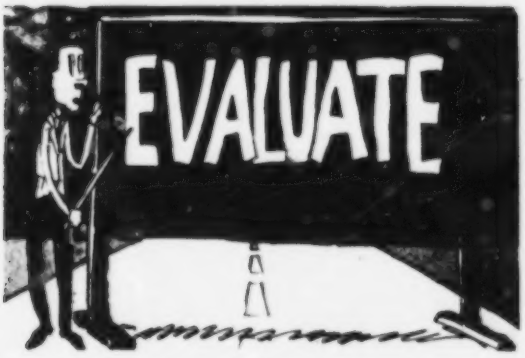
(2) equipment needed

(3) material used

The cost of doing a job depends on 3 things:
1/ Manpower spent
2/ Equipment needed
3/ Material used.

Once the treatment is chosen, we simply add up these three and we know how much treatment can be bought for a dollar. But what about the second question "Is this the best a dollar can buy?"

Sometimes, the best way is the quickest way – but only if there's an emergency such as a wash-out. If the problem affects safety, it's got to be fixed right now and never mind your calculator.



Usually, though, we have time to consider and evaluate the problem, then carefully select the treatment that will give us the most value for our dollar. How do we compare the available treatments in dollars and cents? The answer lies in knowing how long each type of treatment will last – in other words, what is the "Effective Life" of the treatment. The way to compare alternatives is this:

$$\text{unit cost} = \frac{\text{manpower + equipment + material}}{\text{standard accomplishment/day}}$$

First, reduce all the expenses to a basic unit using this simple equation. From it, we see that the unit cost equals the combined costs of manpower, equipment and material, divided by the accomplishment for a day established by the Performance Standard.

unit cost vs life of treatment

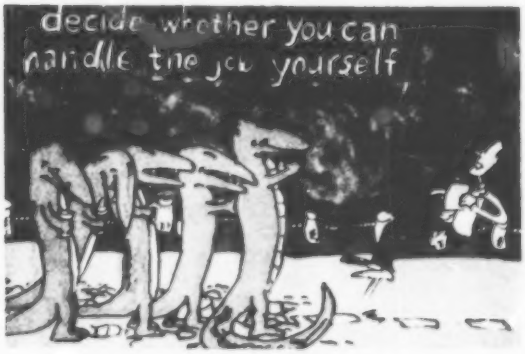
Next, we pit the unit cost against how long the treatment will last. The result is the Equivalent Annual Cost which is the actual cost of any particular treatment we happen to select. So! if we have a number of treatments to choose from, we can now make an easy judgement of which is the most cost-effective.

To sum up:

Ours is a winning system! Because you in the field can now:

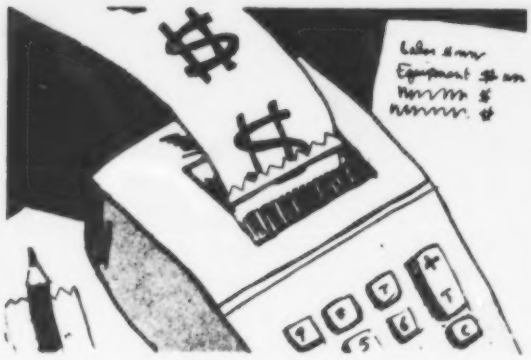
identify the problem and classify it as to severity and density;

choose the treatment that will best solve your particular problem; and



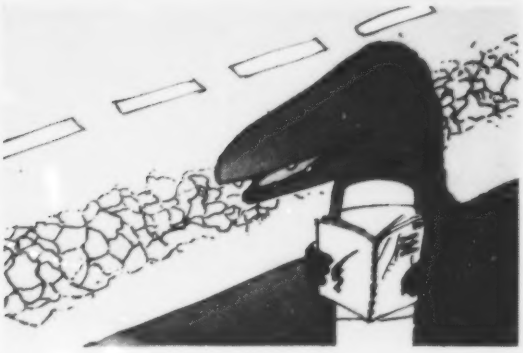
decide whether you can handle the job yourself.

The system means that you know how long each treatment will last.



It means you can figure out the actual costs for each treatment available.

Then make your decision on what to do based on the best cost-effectiveness rating. Now that you know how the system works, let's work out an example:



Here's an old friend – alligator cracking. If we didn't know it so well we could look at the road, look at the book, make a positive I.D. and classify the problem as moderate and local.

In the guide there is a list of recommended treatments for this situation, giving three alternatives: spray patching, cold mix patching, and hot mix patching.

Treatments for Alligator Cracking

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	Density		Routine patrol	Non-patrol	
Moderate	Local	Spray Patch	1004		1
		Cold Mix Patch	1001		1
		Hot Mix Patch	1001 1002	1002	4
		Hot Mix Patch for multi-lanes		1002	4

Next, we decide that the problem isn't too big for us to handle, so we can go ahead and do it ourselves.

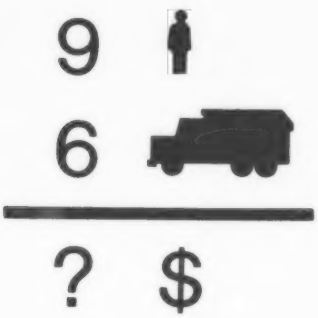
Treatments for Alligator Cracking

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effective Life in Years
Severity	Density		Routine patrol	Non-patrol	
Moderate	Local	Spray Patch	1004		1
		Cold Mix Patch	1001		1
		Hot Mix Patch	1001 1002	1002	4
		Hot Mix Patch for multi-lanes		1002	4

5. Performance Standards for Maintenance Treatments

To evaluate the cost of the job, we turn to the performance standards to find out the crew size, equipment needed, and amount of materials required to fulfill the daily accomplishment for each type of possible treatment.

Flexible Pavement		
Burn (and Seal) Asphalt Pavement	M-1080B	108
Cold Planing	M-1080C	102
Crack Sealing	M-1003	98
Grooving**	M-1080G	
Heater Planing	M-1080H	104



For hot mix patching, performance standard 1002 says we need a 9-man crew, and six different pieces of equipment. So what is all that going to cost?

Sample Labour Cost Chart (Based on $8.05/hr Standard Provincial Labour Rate 1979/80)

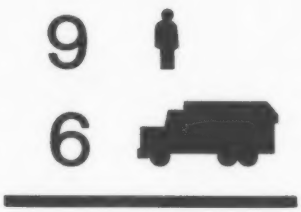
Men in Crew	Hours Worked on Operation and Equivalent Dollar Costs 1	2	3	4	5	6	7	8
1	[illegible]	16.10	24.15	[illegible]	40.25	48.30	56.35	64.40
2	16.10	32.20	48.30	64.40	80.50	96.60	112.70	128.80
3	24.15	48.30	72.45	96.60	120.75	144.90	169.05	193.20
4	32.20	64.40	96.60	128.80	161.00	193.20	225.40	257.60
5	40.25	80.50	120.75	161.00	201.25	241.50	281.75	322.00
6	48.30	96.60	144.90	193.20	241.50	289.80	338.10	386.40
7	56.35	112.70	169.05	225.40	281.75	338.10	394.45	450.80
8	64.40	128.80	193.20	257.60	322.00	386.40	450.80	515.20
9	72.45	144.90	217.35	289.80	362.25	434.70	[illegible]	579.60
10	80.50	161.00	241.50	322.00	402.50	483.00	[illegible]	644.00

Manpower costs are usually fixed at the start of each fiscal year. So a labour cost chart like this one available from your district office, gives you a quick and easy reference. One 9-man crew for this job is going to cost $579.60 per day.

There's a similar chart for equipment rental. The six pieces we need will cost $329.40 per day.

Pre-Identified Equipment Listing and Rental Rates

Description Type	MTC Equipment Code	Current (1979) Rental Rates $/hr
1/2 ton pick-up	0003	$3.00
3/4 ton pick-up	0006	3.10
3/4 ton 5 man cab	0006	3.10
1 1/2 ton stake/hoist	0023	
1 1/2 ton 5 man cab		
6 pieces of equipment		$329.40



To find out the accomplishment expected of our crew, we look at the performance standards. From them, we discover that 9 men using six pieces of equipment can be expected to lay an average of 70 tonnes in a day.

9

6

70 tonnes/day

Location and time of year can alter the cost of materials, but reasonably accurate estimates can be obtained from the supplier or your district office. For example, at $20.04 per tonne, 70 tonnes of hot mix will cost $1402.80.

$20.04/tonne

x 70

$1402.80

$579.60
329.40
1402.80
$2311.80 total cost/day

When we add all this up – $579.60 for manpower, $329.40 for equipment and $1402.80 for material – we end up with a grand total of $2311.80. This is the total cost per day for the job.

$$\frac{\text{total cost/day}}{\text{accomplishment/day}} = \text{unit cost}$$

$$\frac{\$2311.80}{70} = \$33.03$$

Now we have the total cost per day, we can work out the unit cost per day. To do this, we divide the total cost by the accomplishment per day: $2311.80 divided by 70, gives us a unit cost of $33.03.

Treatments for Alligator Cracking

Evaluation		Recommended Maintenance Treatment Alternatives	Maintenance Function Classification		Expected Effectiveness
Severity	Density		Routine patrol	Non-patr	
Moderate	Local	Spray Patch	1004		1
		Cold Mix Patch	1001		1
		Hot Mix Patch	1001 1002	1002	4
		Hot Mix Patch for multi-lanes		1002	4

One more variable has to be taken into account before we can reach a final figure for the actual cost of any job. Different treatments are going to last for different lengths of time. This affects actual cost over the years.

$$\frac{\text{unit cost}}{\text{expected life}} = \text{actual cost}$$

We can take this time factor into account by dividing the unit cost by the number of years we expect the treatment to have a useful life. The hot mix in our present example has an expected life of four years.

$$\frac{\$33.03}{4} = \$8.26 \text{ tonne/year}$$

In other words, the actual cost, or Equivalent Annual Cost, for hot mix patching (1002) is $33.03, which, you remember is our unit cost, divided by four, the years of expected treatment life, — $8.26 per tonne per year.

spray patching 77¢/L/year

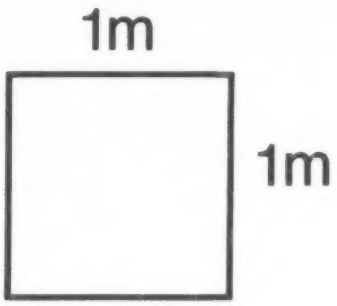
cold mix $35.47 tonne/year

We can work out the Equivalent Annual Cost for each of our other alternatives in the same way. Spray patching will cost 77¢ per litre per year. Cold mix will cost $35.47 per tonne per year.

equivalent annual costs

spray patching	cold mix	hot mix
77¢ L/year	$35.47 tonne/ year	$8.26 tonne/ year

Now let's compare the three Equivalent Annual Costs. Hot mix patching is obviously more cost-effective than cold mix. But how are we to judge spray patching?



This is well nigh impossible unless we go one step further and take into account the area of pavement we intend to repair and the quantity of materials to be used. The simplest way to do this is to reduce everything to a common unit of one square metre.

spray patching

1.8 L/m²

Let's start with spray patching. The Estimating Manual says that 1.8 litres is the standard quantity to be applied to one square metre.

alligator cracking

40% increase

But it recommends this quantity be increased by 40% when the treatment's used to deal with our problem of alligator cracking.

1.8

+ 40%

2.5 L/m^2

So – if we increase 1.8 litres by 40%, we can say that the rate of application for spray patching in our job would be 2.5 litres per square metre.

1 L costs 77¢

2.5 cost $1.93

application cost

$1.93 /m^2/year

We know the Equivalent Annual Operation Cost of spray patching is 77¢ per litre per yea so it's an easy task to work out the application cost as $1.93 per square metre per year.

hot mix
(0.0228 tonnes)

22.8 kg

1cm

Going back to the Estimating Manual once more, we find that the standard application rate of hot mix for one square metre is 22.8 kg, which is 0.0228 of a tonne. This will give a cover of one centimetre thickness.

equivalent annual cost

$8.26/tonne/year

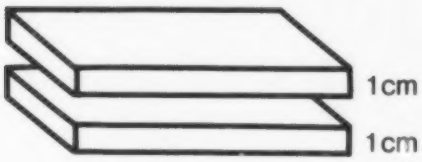
We've already worked out the Equivalent Annual Cost of hot mix patching to be $8.26 per tonne per year. So its relatively simple now to calculate the application cost for our job.

application cost

$8.26 x 0.0228

= 18¢/m^2

To work out the application cost, we multiply the Equivalent Annual Cost, in this case $8.26, by the standard application rate over one square metre, 0.0228 tonne. This gives an application cost of 18¢ per square metre.

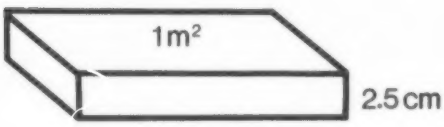


36¢/m²/year

2.5 cm costs 47¢/m²/year

If we want to make our patch two centimetres in thickness, it's going to give us an application cost of 36¢ per square metre per year. If we make the patch 2.5 centimetres in thickness, the application cost will be 47¢ per square metre per year.

cold mix



$2.02 m²/year

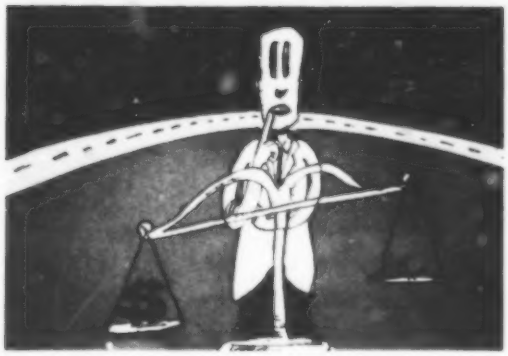
The application cost for cold mix can be worked out in the same way. For the job we're talking about here, a cold mix patch 2.5 centimetres thick, would cost $2.02 per square metre per year.

spray patching	cold mix	hot mix
$1.93	$2.02	$.47

Now, let's line up the three treatments once again and compare their Equivalent Annual Cost for one square metre.

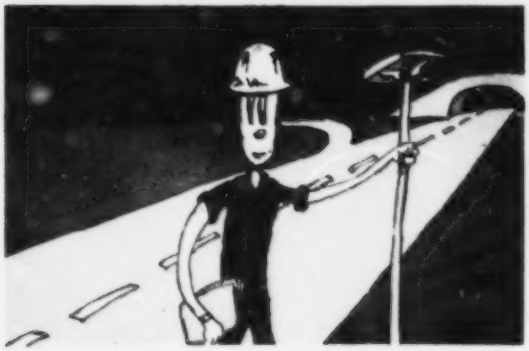
Hot mix patching is obviously the most cost-effective solution to our problem.

hot mix $.47



The treatments recommended in the guide are the most cost-effective.

But sometimes, special circumstances will mean that the most cost-effective treatment is not necessarily your best choice. For example, you may work in an area where hot mix is simply not available. So there's no point in your recommending it as the best available treatment – you have to stay with the the other two alternatives.



The system is really quite simple. Once you've used it a few times, you'll wonder how you ever managed without it. Work out the cost-effectiveness of a treatment once – and you won't have to do it again. You can just use it in the next situation when you need it. So remember – the system's a winning one. Let's use it!

Ministry
of
Transportation
Ontario